SKF

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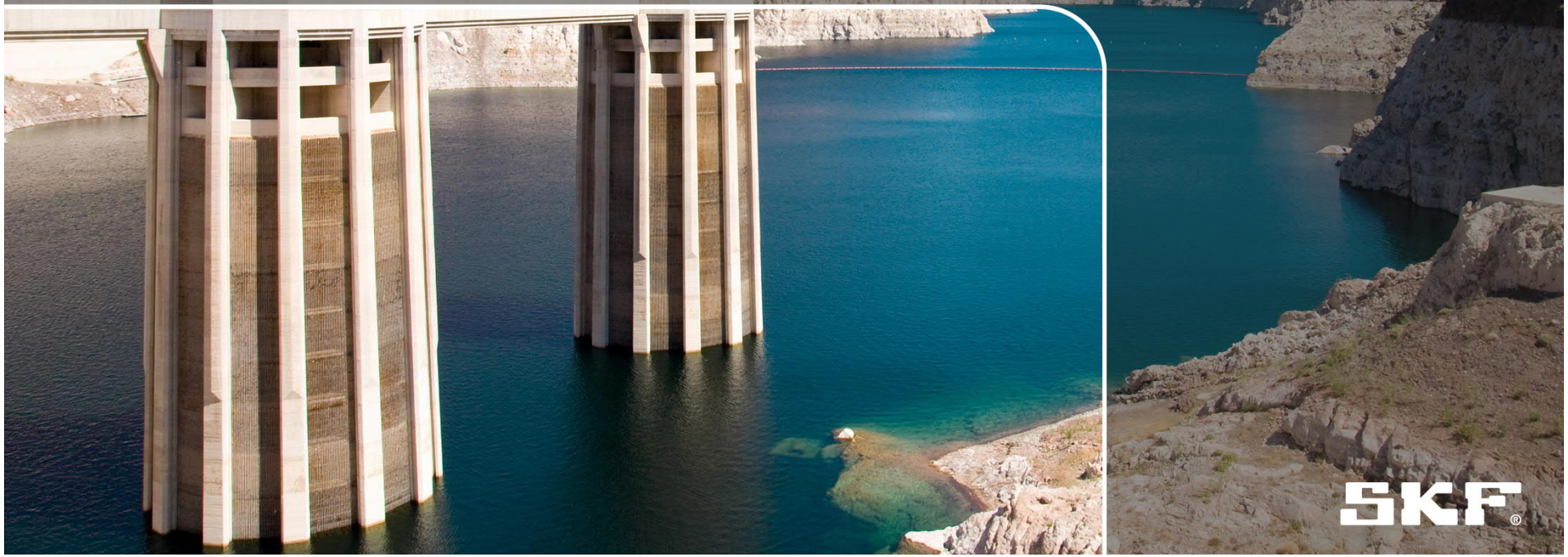
Global Seals Application Engineering Manager

SKF Regional Sales & Services

SKF machined seals
Hydro power capabilities



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4. Spherical valve seals
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7. Ring gate seals
8. Others/ Special applications

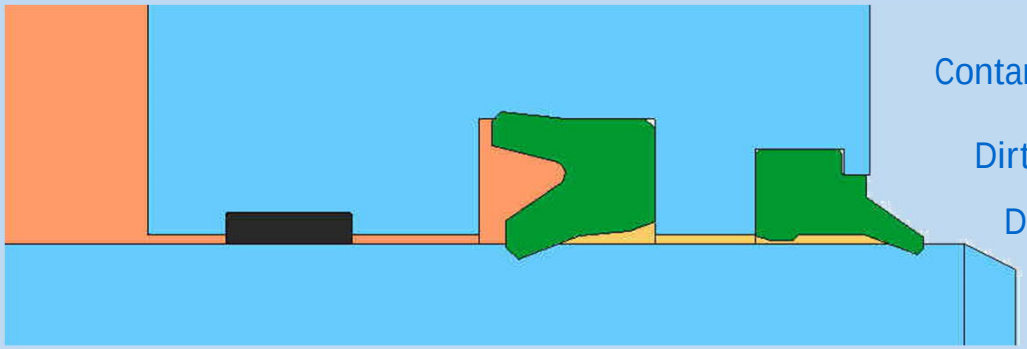
1

General Information

Complexity of sealing – influencing factors

Customer expectations

Reliable function
No stick-slip
Long lifetime
Easy mounting
Low friction
No leakage
Small housing sizes
Low cost (economical)



Pressure
Temperature
Sliding speed
Stroke length
Contamination
Dirt
Temperature
Dust
Mud
Water
Ice
UV / ozone
Intermediate pressure
Surface roughness
Sliding surface
Tolerance
Viscosity
Guide clearance
Extrusion gap size
Eccentricity
Side loads
Frequency
Chemical resistance
Surface coatings

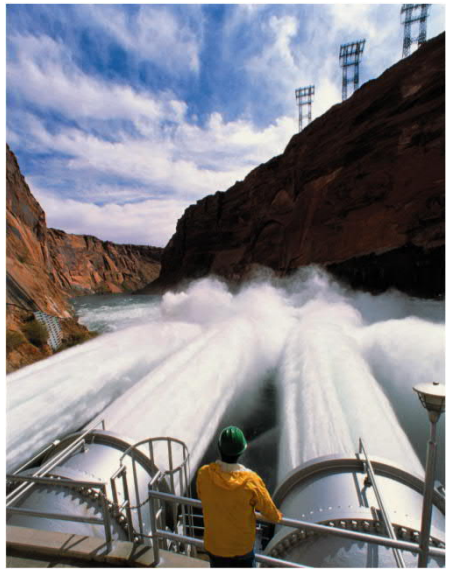
Hydro power plants

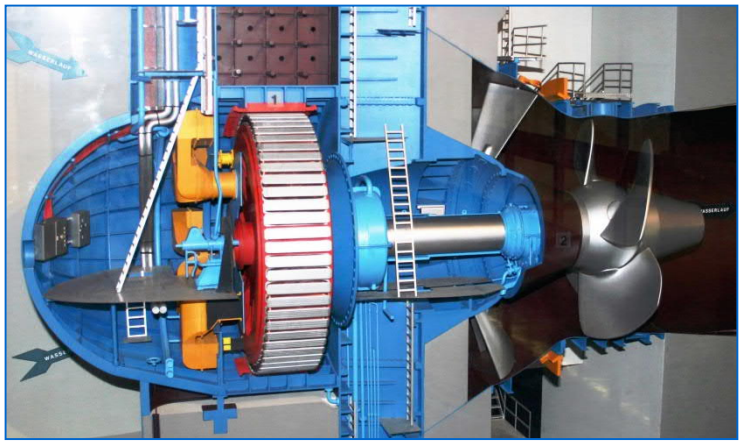
Key requirements in hydro industry

reliable sealing function, 24/7

mountability – case of repair

high wear resistant materials- sediments

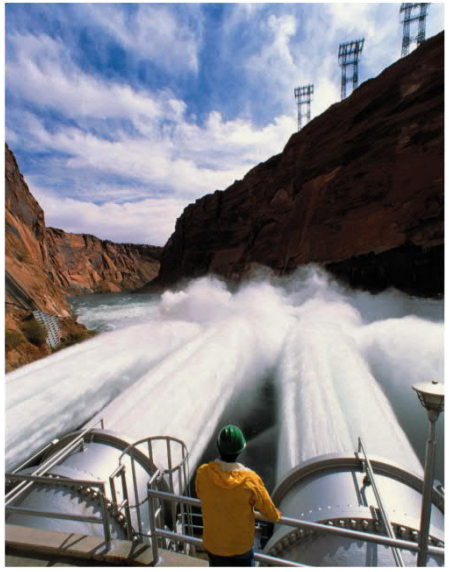


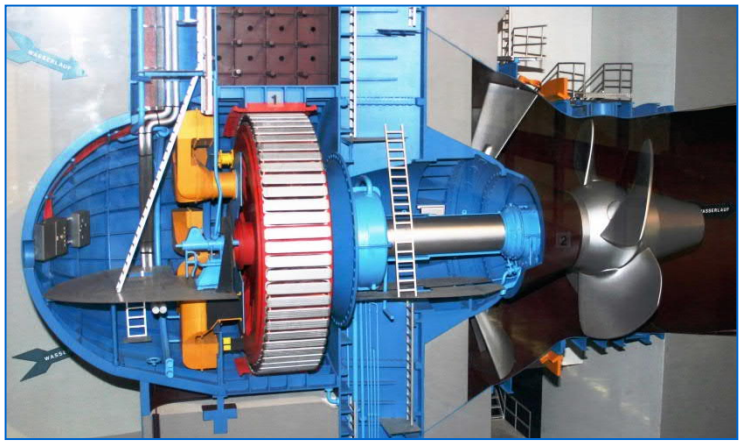


Hydro power plants

SKF features for hydro industry

- years of experience
- huge selection of high quality material’s
- no design limitation, flexible machining process

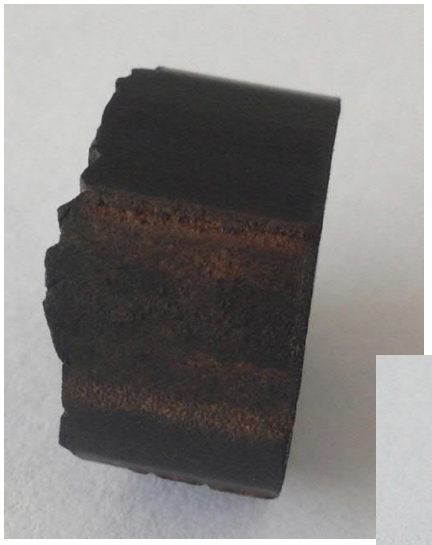


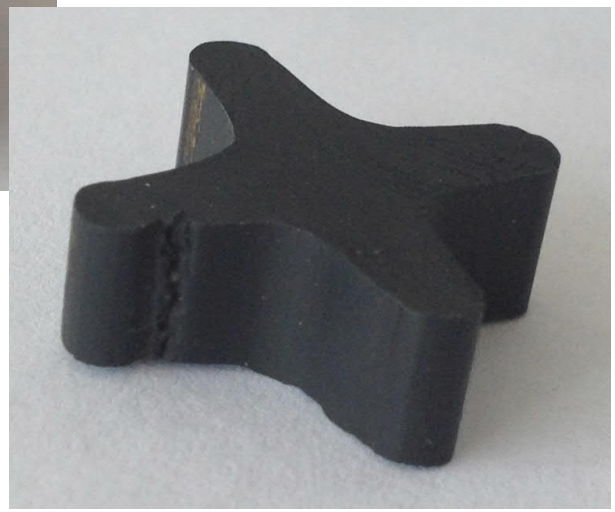


Hydro power plants

typical failure mode

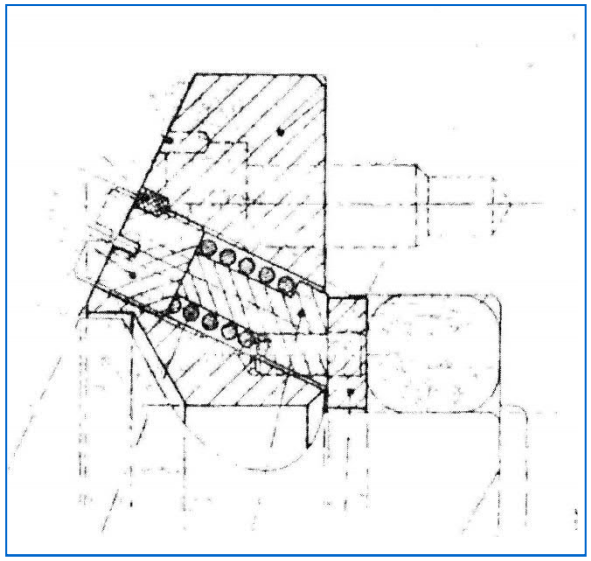
- abrasive particles, sediment
- wrong or not ideal seal design
- wrong or not ideal material choice
- damaged surface





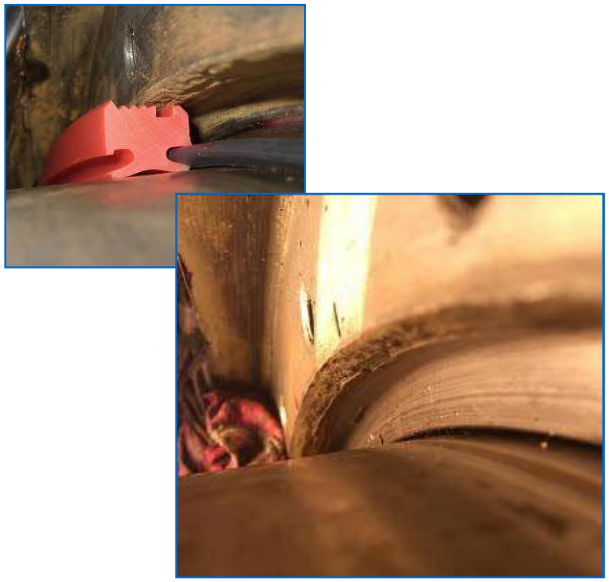
Rotor blade seals

Problems can occur when using simple O-ring or X-ring solutions



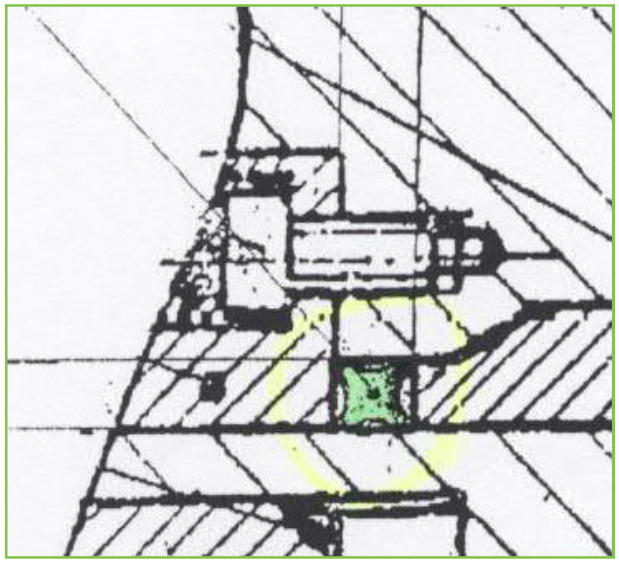
O-ring does not cover whole metal housing and sealing surfaces on OD and ID → ingress of water and contamination

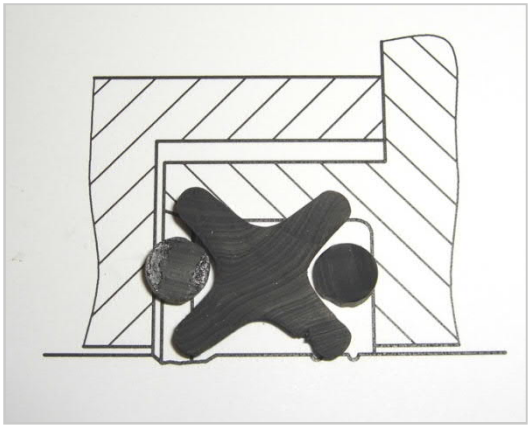
Used O-ring showing deformation and compression set as well as corrosion marks from housing



Extreme housing damage due to inefficient protection of housing from ingress of water and contamination.

Rotor blade seals





TPU materials - Standard grades

S-ECOPUR – 95 Shore A

(G-ECOPUR SL > 600mm)

[TPU + solid lubricants]

Optimized in regard of tribological characteristics (wear and friction)

achieved by an addition of a synergetic combination of solid lubricants

Outstanding sliding properties

Excellent wear and abrasion resistance

Good chemical resistance

Working temperature range: -20 °C to 110 °C

TPU materials - Standard grades

H-ECOPUR – 95 Shore A

(G-ECOPUR > 600mm)

[Hydrolysis resistant TPU]

Mechanical properties similar to ECOPUR

High hydrolysis stability and high chemical resistance

Very low gas permeability

Suitable for food and beverage applications

Working temperature range: -20 °C to 110 °C

TPU materials - Standard grades

T-ECOPUR – 95 Shore A

[Low temperature TPU]

Very good elastic behaviour even at temperatures up to -50 °C

Working temperature range: -50 °C to 110 °C

Customers: Hydro power

OEM:

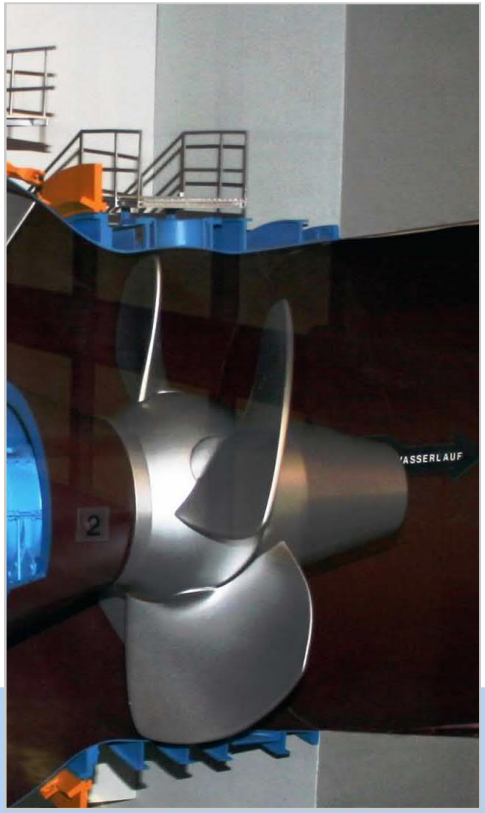
- ANDRITZ
- LITOSTROJ
- HARBIN
- DONGFANG
- UCM RESITA
- DOUCE HYDRO
- D2FC
- TB HYDRO
- VOITH
- ALSTOM HYDRO

MRO:

- VERBUND
- DEM
- VIW
- TIWAG
- ENDESA
- IBERDROLA
- SLOVENSKE ELEKTRARNE
- RARIK
- ENEL
- KEMIOKI
- EDF
- HYDRO QUEBEC

2

Rotor blade seals



Rotor blade seals

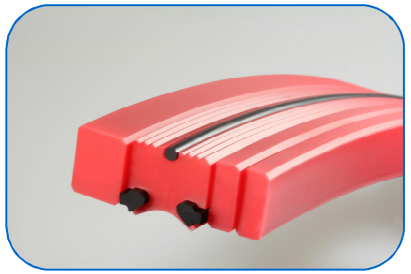
Customized sealing solutions for non-standard housings; suitable for separating oil and water.

Large variety of possible seal designs

- Compact seals
- Flexible lip seals
- Chevron sets

Flexibility in size and design to cover specific application requirements like

- Small housing sizes
- Large misalignments
- Compensating housing irregularities
- Replacements for O-rings, X-rings or similar solutions

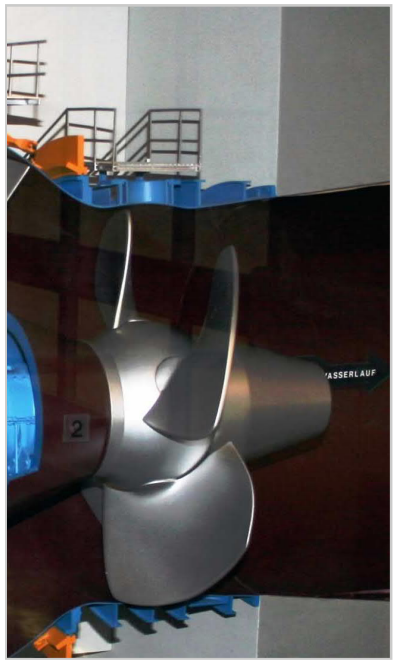


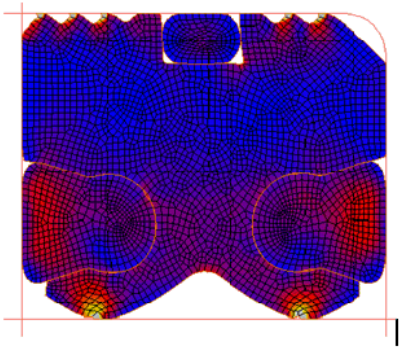
Compact seal

Flexible lip seal

Chevron set

NEW development- Rotor blade seal





installed Seal (FEA)

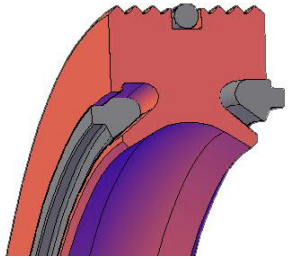
solution:
tailormade double acting profile in polyurethane with rubber energizer elements, serrated OD + static O-ring

advantages:
reliable sealing effect due to optimized lip and energizer design
compensating misalignment and easy to mount because of special energizer geometry
compact, space saving design
available for endless and split welded version

Rotor blade seals

solution:

tailormade double acting profile in polyurethane with rubber energizer elements



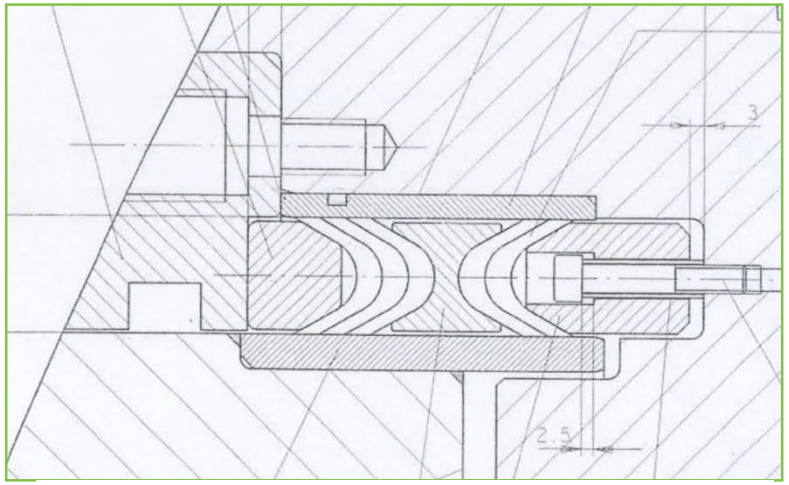
advantages:

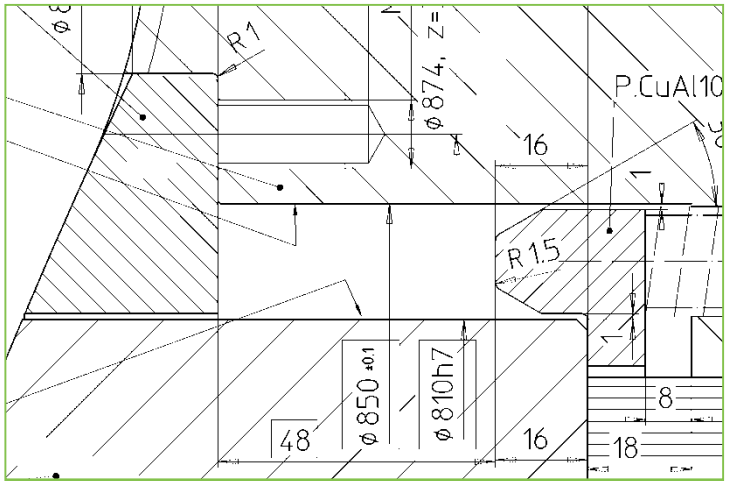
only small housing size required fits in commonly used O-ring / X-ring grooves

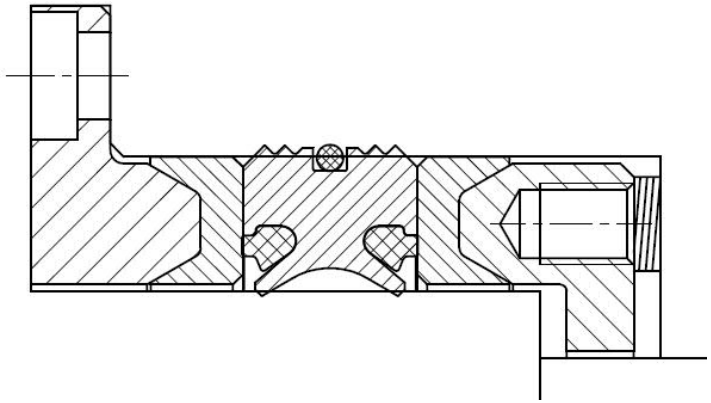
protects housing and shaft from damage

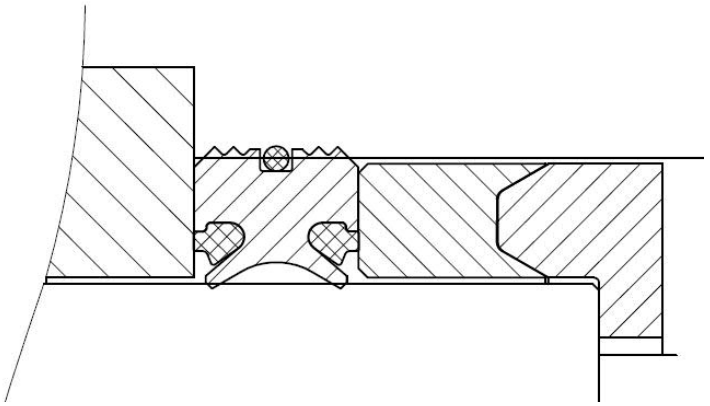
Rotor blade seals

solution can be adopted to many existing housing designs









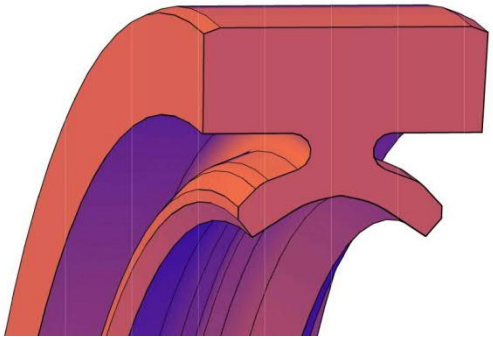
Video

Rotor blade seals

special sealing solutions (split and non-split designs)

solution:

one part lip seal design in polyurethane

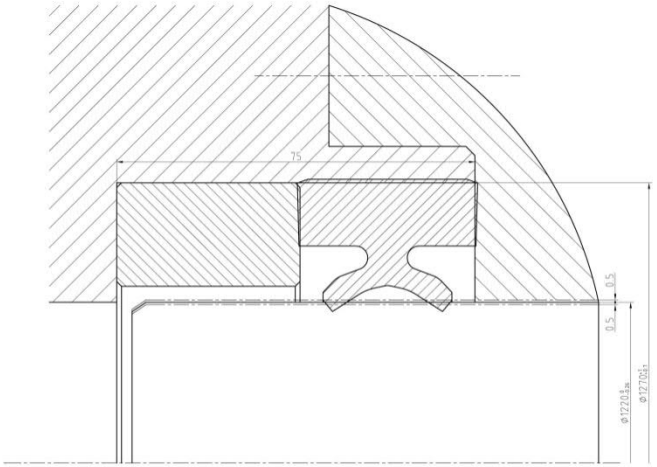


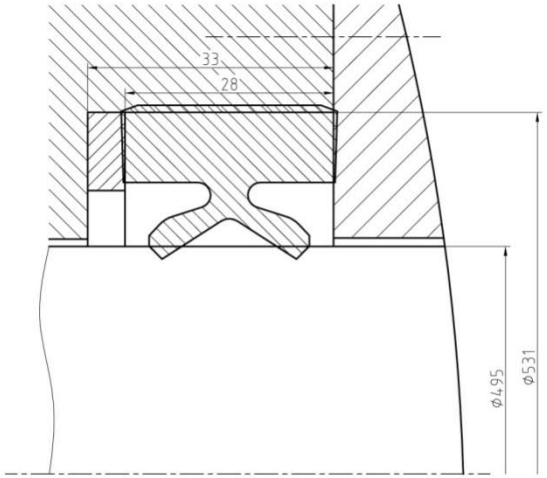
advantages:

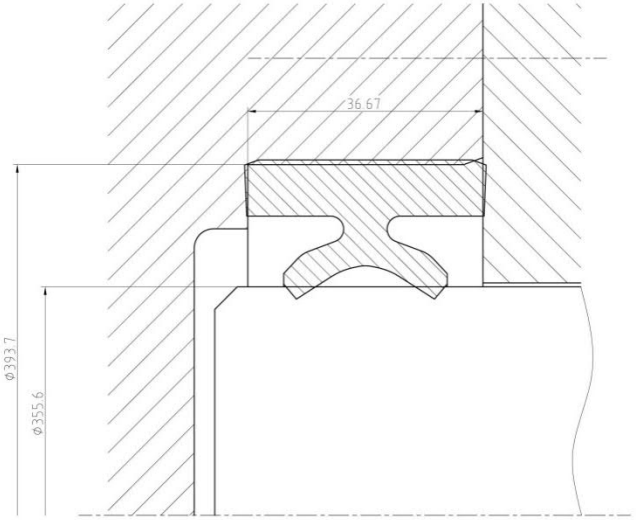
flexible lip design,

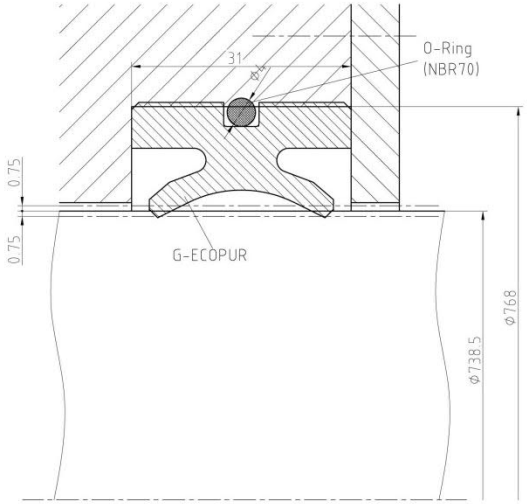
compensating large misalignment

Rotor blade seals



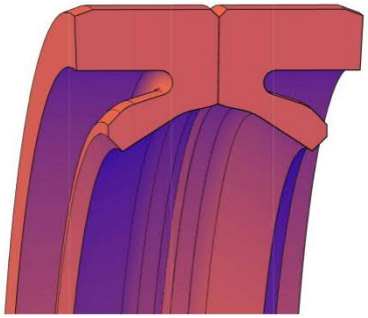


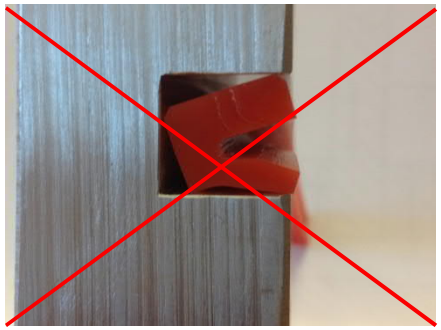


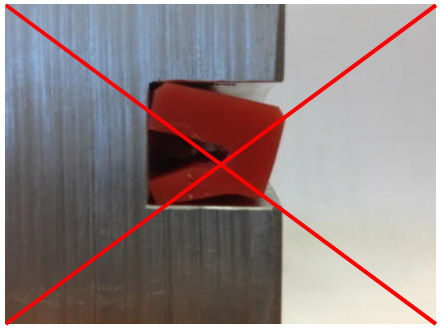


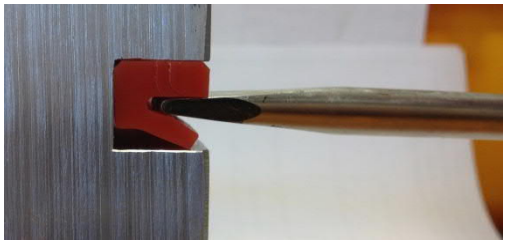
Rotor blade seals

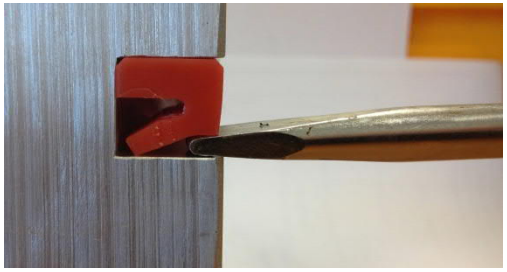
A single seal is not so stabile and can very easy bend in the housing!

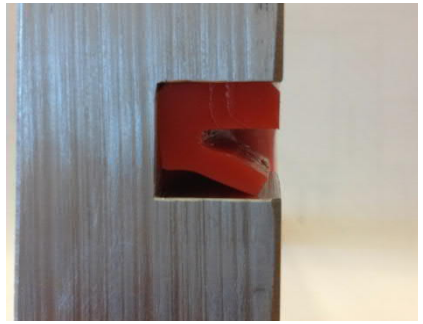


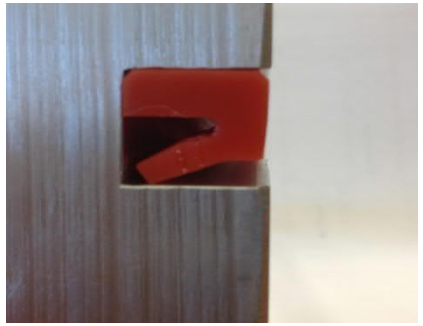












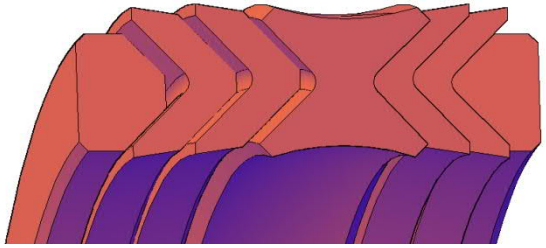
using a screwdriver
(no sharp edges) the seal can
be placed in the right position.

Rotor blade seals

special sealing solutions (split and non-split designs)

solution:

tailormade double acting polyurethane chevron set



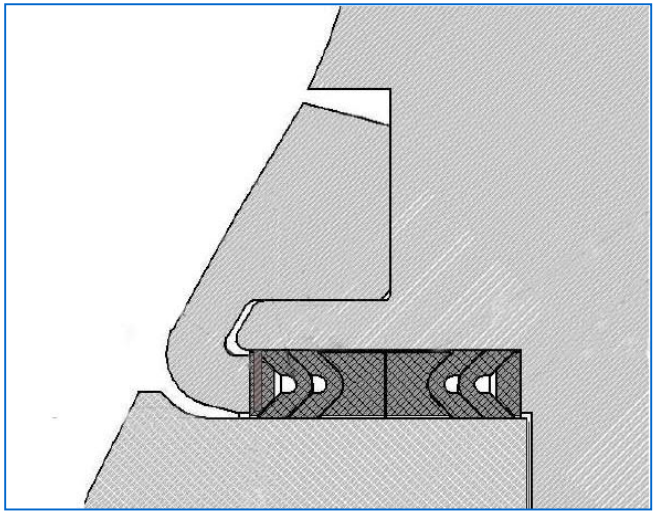
advantages:

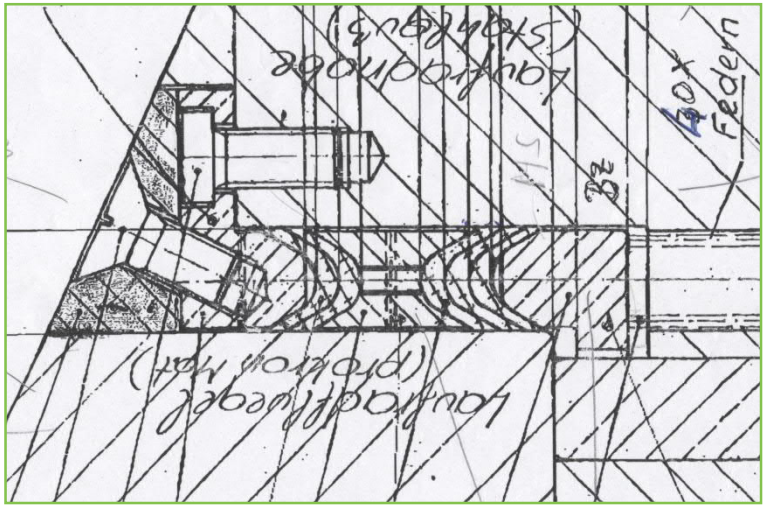
multi-lip design for reliable sealing function,

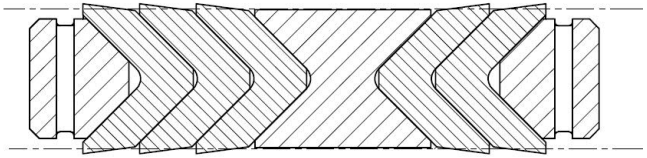
split installation possible without on-site joining

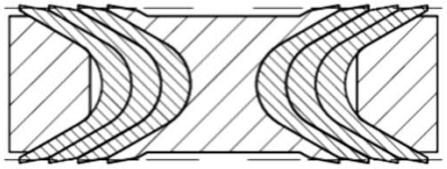
Rotor blade seals

special double-acting chevron set solutions



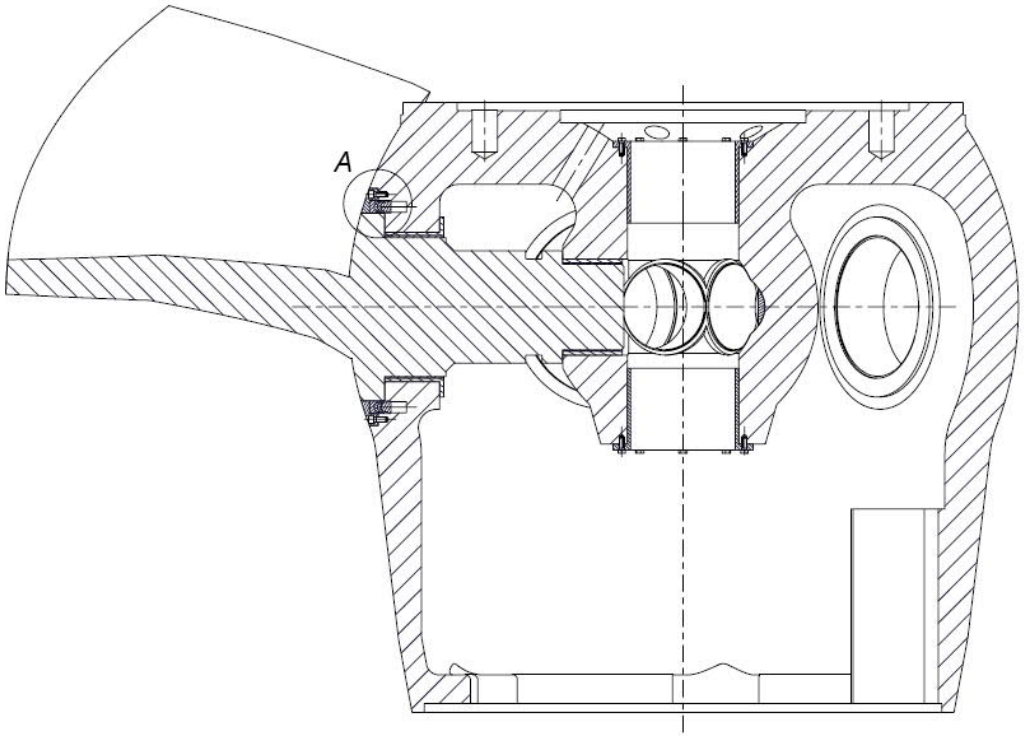


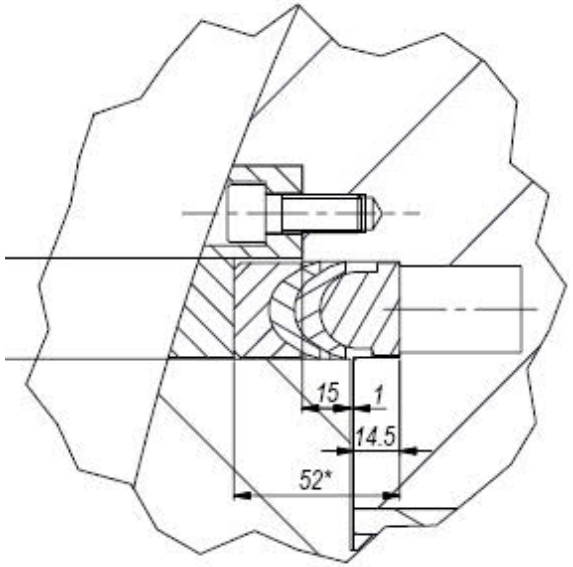


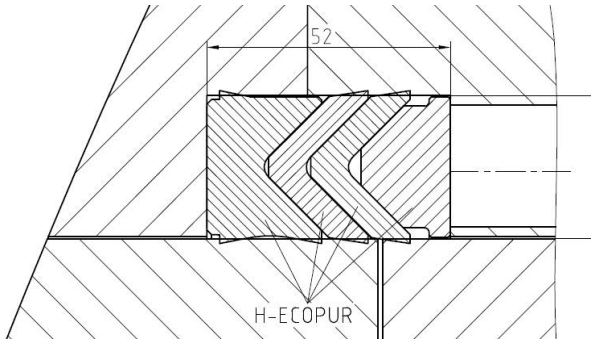


Rotor blade seals

special double-acting chevron set solutions

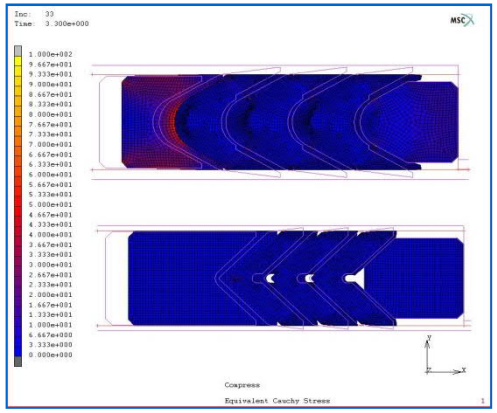






S1012 friction force

Compression of Chevron Packings



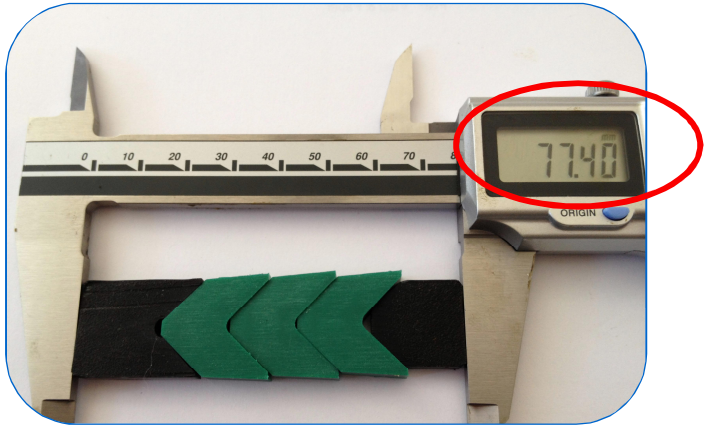
-extremely high increase of friction if the chevron packing is compressed

-damaging of the first V-ring

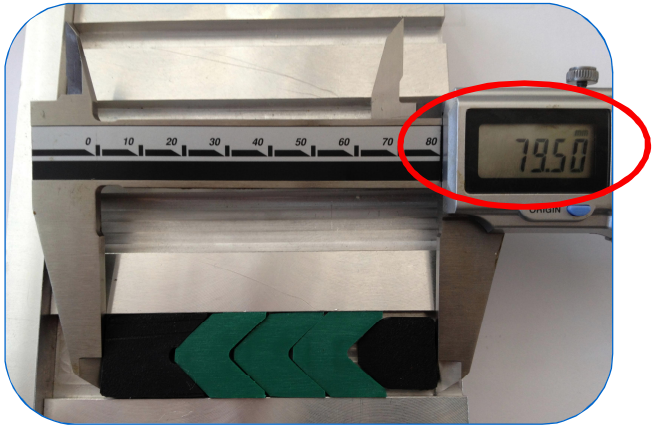
-damaging of the back-up ring

-high wear and heat due to the high friction

S1012 in mounted position



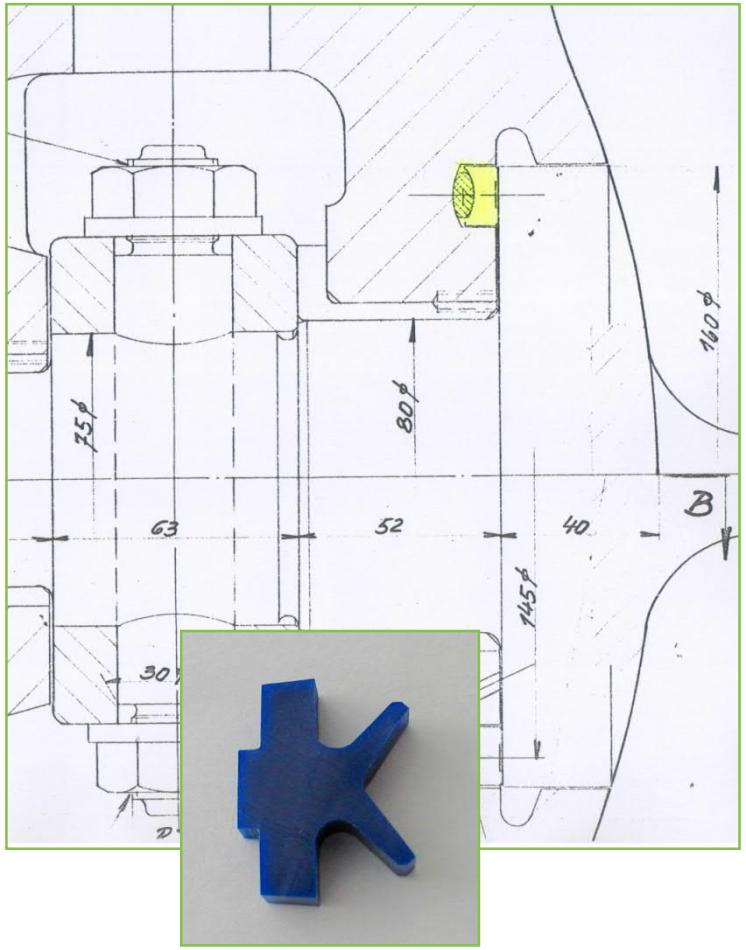
Seal in uninstalled position

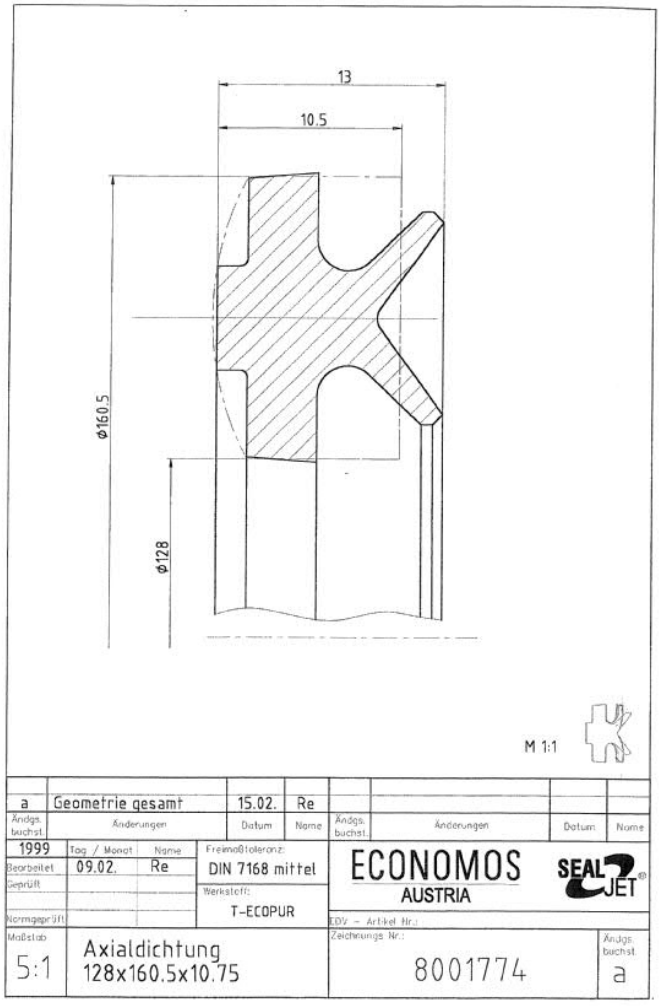


Seal in installed position

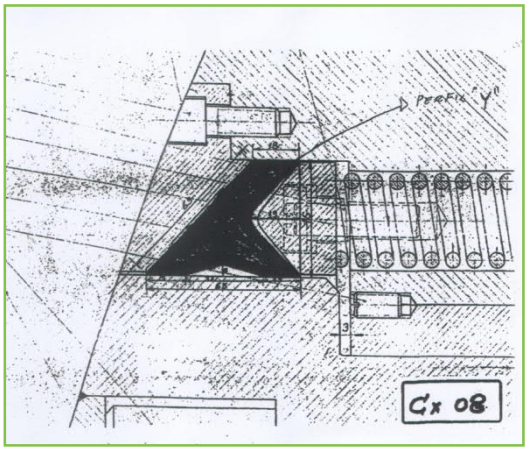
The total seal height will increase in mounted position due to the preload on the chevrons.

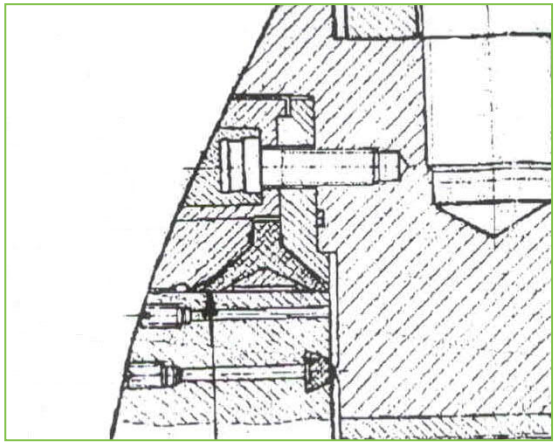
Rotor blade seal specials

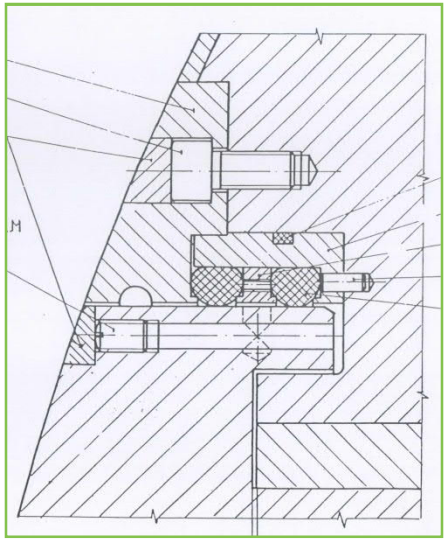


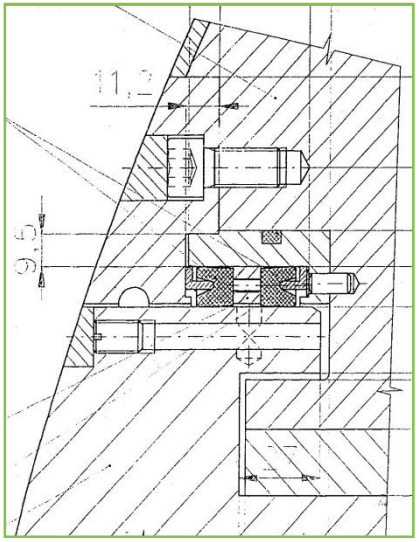


Rotor blade seal specials







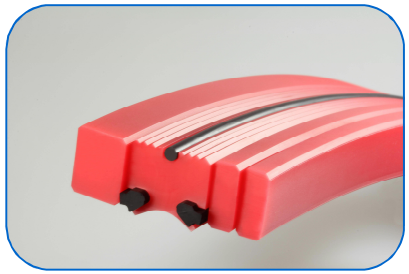


Rotor blade seals

Customized sealing solutions for non-standard housings; suitable for separating oil and water.

Benefits

- Reliable solutions
- High abrasion resistant materials
- Excellent resistance against sediments
- Long seal service life
- Easy and fast installation
- Reduced downtime
- Mounting split, endless or on-site jointing
- On-site welding and installation service



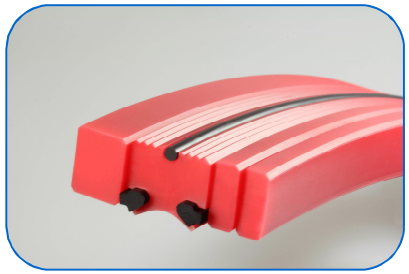
Compact seal

Flexible lip seal

Chevron set

Rotor blade seals

FALA Slovenia	*rotor blade seal*	*810x850x38.5*
MELLACH Austria	*rotor blade seal*	*705.5x740.7x23*
JINGPING China	*rotor blade seal*	*705.5x740.7x23*
LAGARFOSS Iceland	*rotor blade seal*	*670x700x42*
SVEG Sweden	*rotor blade seal*	*746x780x49*
NOVE MESTE Slovakia	*rotor blade seal*	*546x584x47*
KIRCHBICHL Austria	*rotor blade seal*	*430x442.8x13*
KRPELANY Slovakia	*rotor blade seal*	*527.8x550x33*
NOSICE Slovakia	*rotor blade seal*	*650x684.25x50*
HANGSHOU China	*rotor blade seal*	*1230x1262x35*
WEINZÖDL Austria	*rotor blade seal*	*700x726x21*
KIRCHBICHL Austria	*rotor blade seal*	*430x442.8x13*
ASTEN Austria	*rotor blade seal*	*1080x1126x30*
PORTTIPAHTA Finland	*rotor blade seal*	*1020x1055x40*
MADUNICE Slovakia	*rotor blade seal*	*525x550x33.5*
HRICOV Slovakia	*rotor blade seal*	*738x772.5x48*
TAIVALKOSKI Finland	*rotor blade seal*	*1135x1173x61*
Mockfjärd Sweden	*rotor blade seal*	*950x982x64*



Compact seal

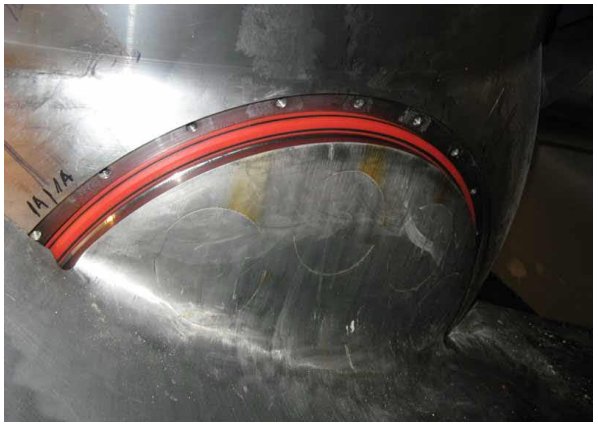
Flexible lip seal

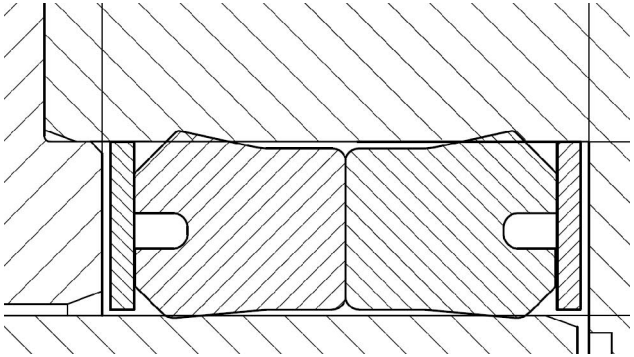
Chevron set

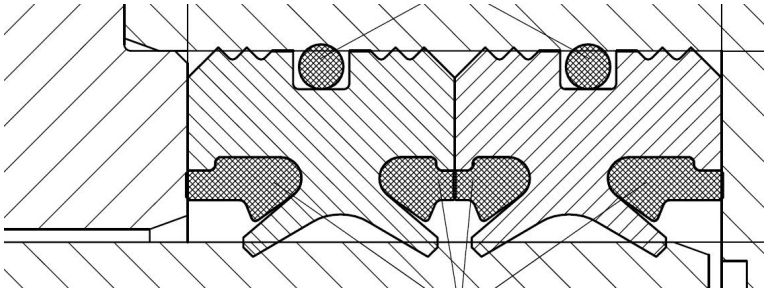
On-site-joining of rotor blade seals

Video

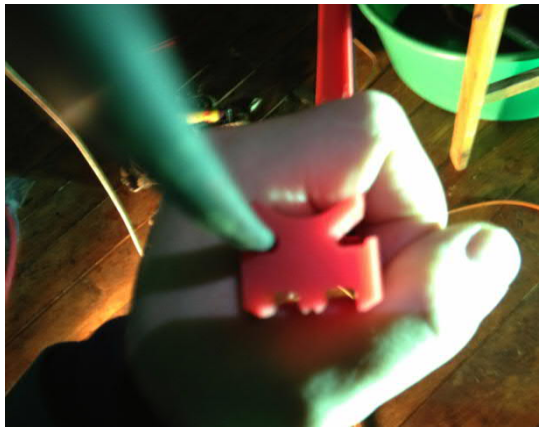
HPP „Lagarfoss“ ICELAND – rotor blade seals

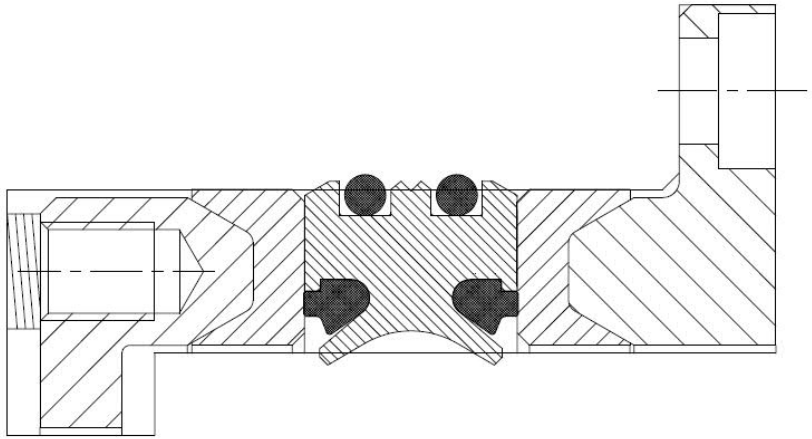


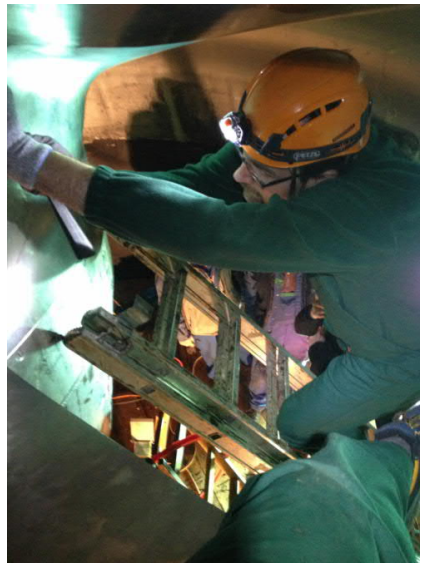




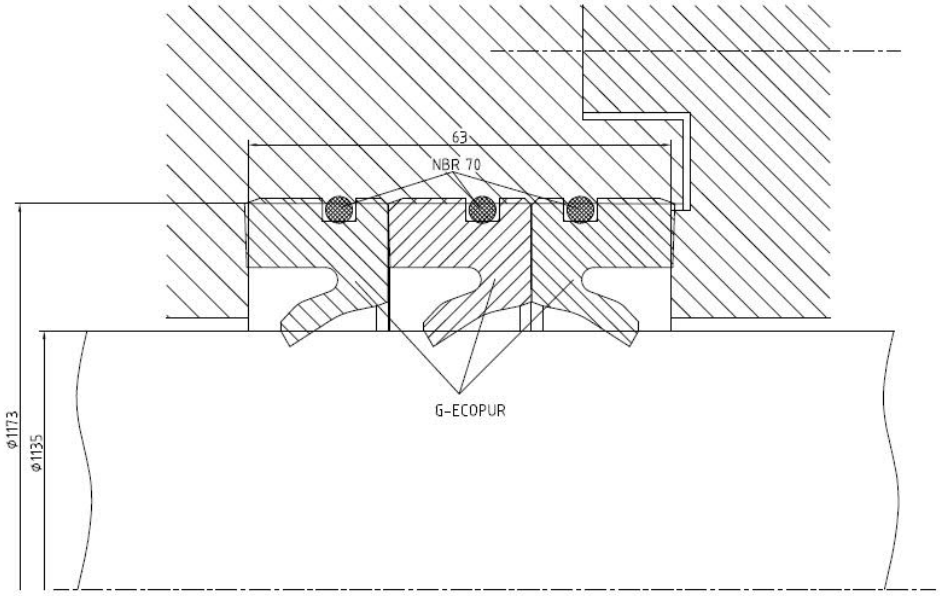
Fala- Rotor blade seal



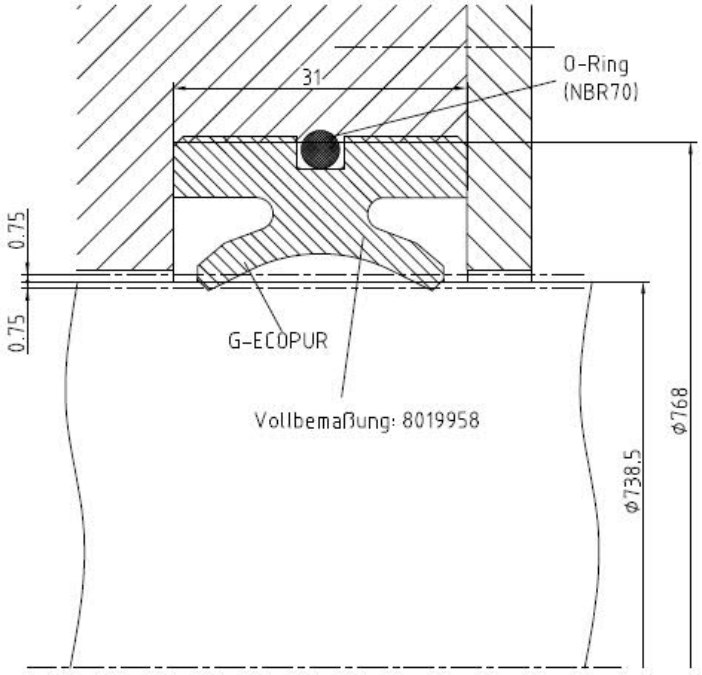




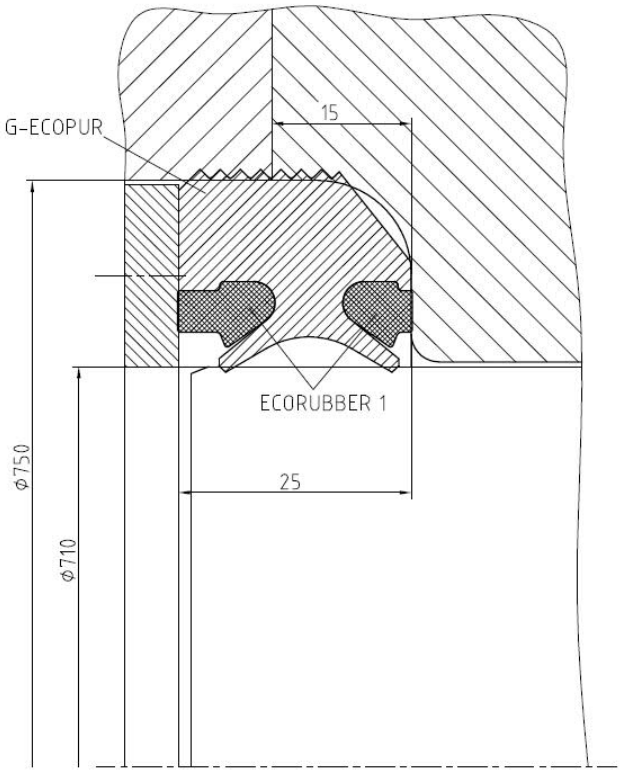
Taivalkoski- Rotor blade seal



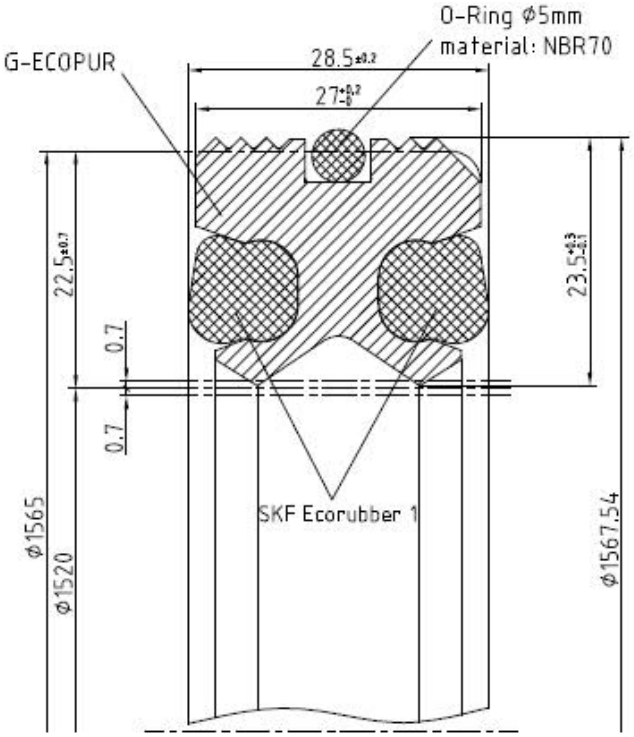
La Pena- Rotor blade seal



Menuza- Rotor blade seal

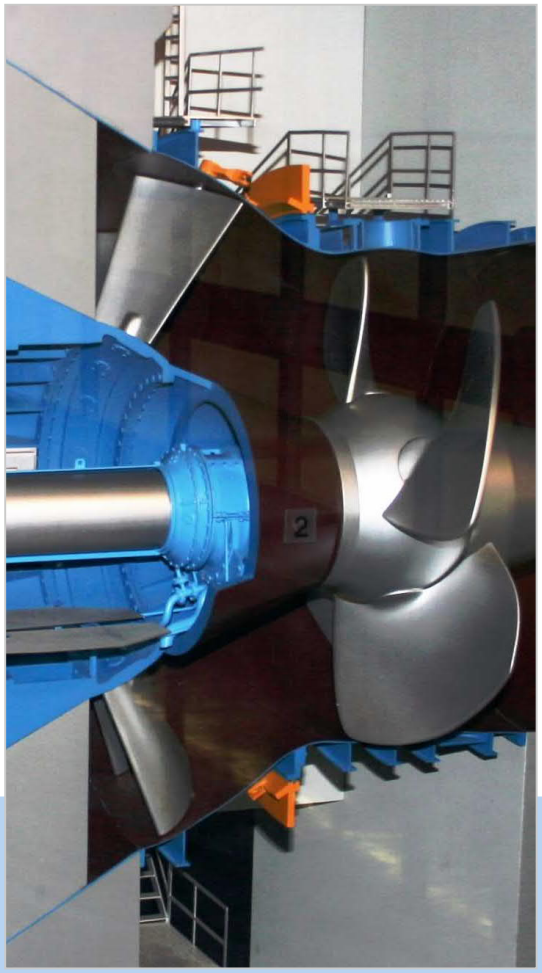


Cedillo- Rotor blade seal



3

Wicket gate seals



Wicket gate seals

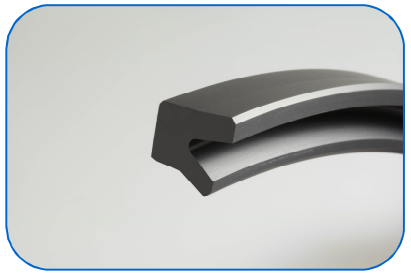
Customized single acting sealing solutions made of self-lubricating materials; especially suitable for pivoting and vibrating motion in all pressure ranges.

Large variety of possible seal designs

- Lip seals
- Compact seals
- Chevron sets

Flexibility in size and design to cover specific application requirements like

- Optimized profiles for pivoting in low pressure ranges
- Flexible sealing lip to compensate misalignments
- Low friction to avoid stick-slip tendency
- Vibration-proof solutions



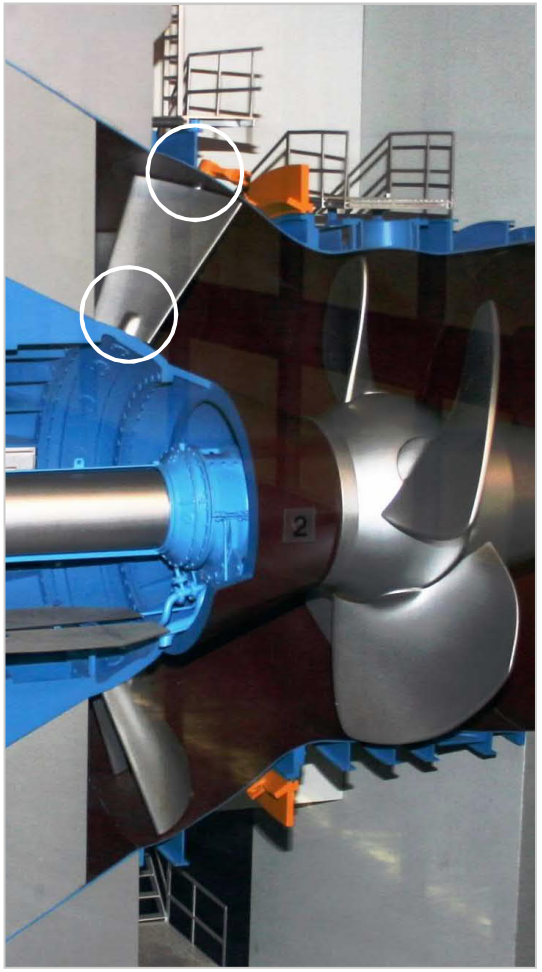
Lip seal

Compact seal

Chevron set

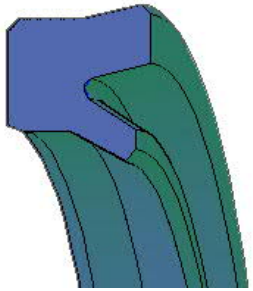
example: wicket gate seals (guide vanes)

special sealing solutions (special developed material)



solution:

Lip seal in special low temperature polyurethane „T-ECOPUR“ or in **special self lubricating polyurethane „S-ECOPUR**“ ,lip shape adopted to work in low pressure range



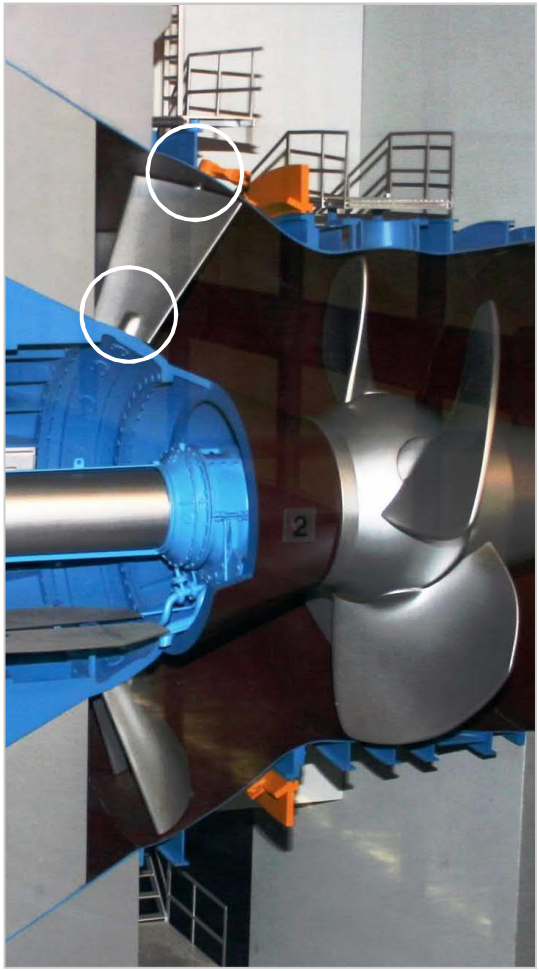
advantages:

good wear resistance,

excellent low temperature flexibility

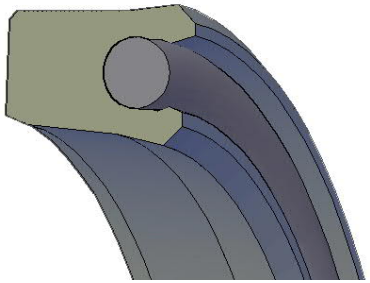
example: wicket gate seals (guide vanes)

special sealing solutions (special developed material)



solution:

O-ring energized compact seal in special self lubricating polyurethane „S-ECOPUR“

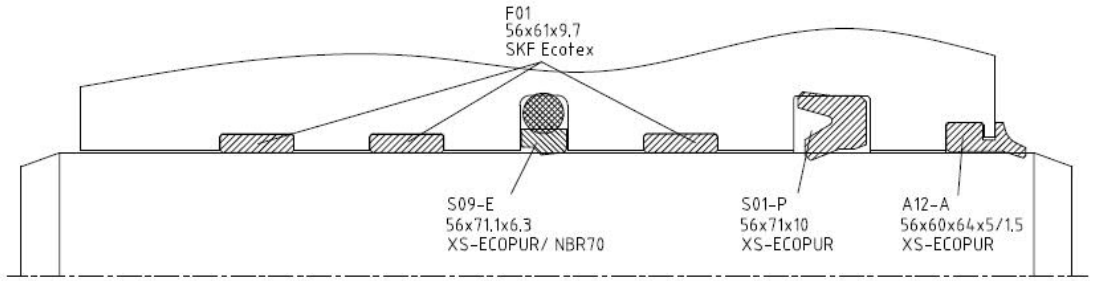


advantages:

good wear resistance,

excellent low friction behaviour,
low stick-slip tendency, low break-away force after stillstand periods

servo motors controlling wicket gates

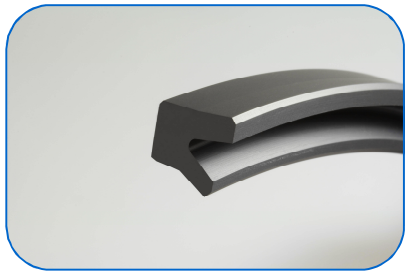


Wicket gate seals

Customized single acting sealing solutions made of self-lubricating materials; especially suitable for pivoting and vibrating motion in all pressure ranges.

Benefits

- Reliable solutions
- Special self-lubricated materials
- High abrasion resistant materials
- Excellent resistance against sediments
- Long seal service live
- Designs for endless and split installation



Lip seal

Compact seal

Chevron set

4

Spherical valve seals

Spherical valve seals

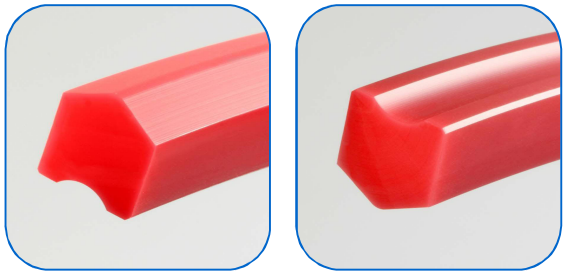
Standard and customized single and double acting sealing solutions; suitable for large common deformations and misalignments of mobile rings; easy to install.

Large variety of possible seal designs

- Compact seals
- O-ring loaded cap seals
- Lip seals
- Single- and double acting

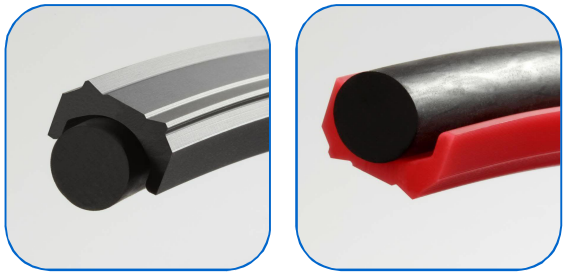
Flexibility in size and design to cover specific application requirements like

- Space saving design to fit small housings
- High dimensional stability under pressure
- Less deformation and relative movement during pressurization
- No twisting or spiralizing during installation or operation
- Compensating deformation and misalignment of mobile ring



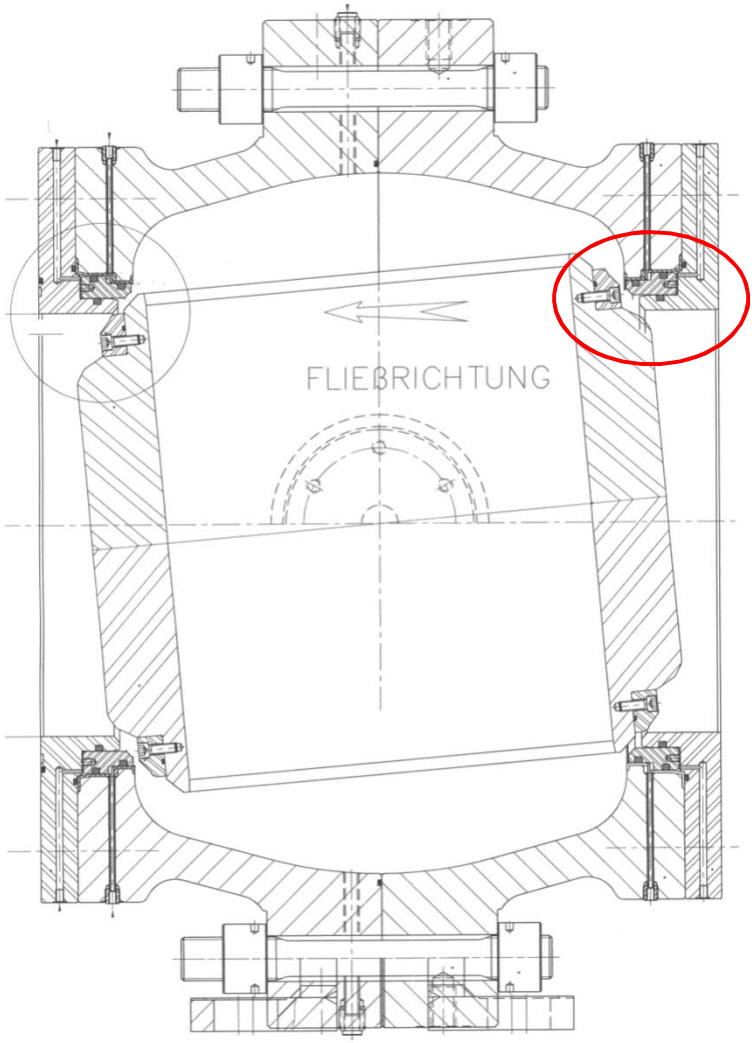
Compact seal

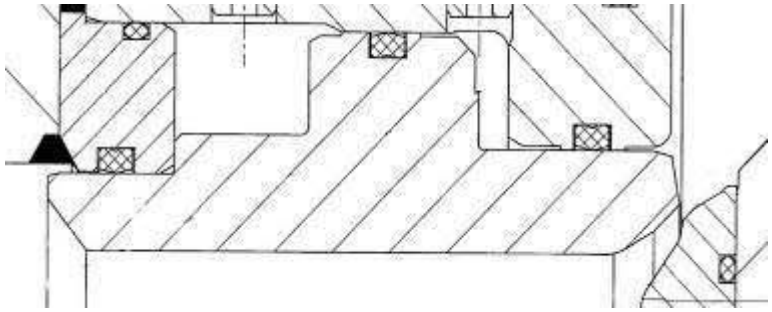
Compact seal



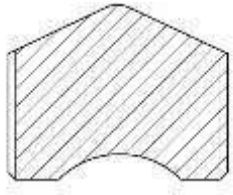
O-ring loaded cap seal

Spherical valve seals – mobile ring





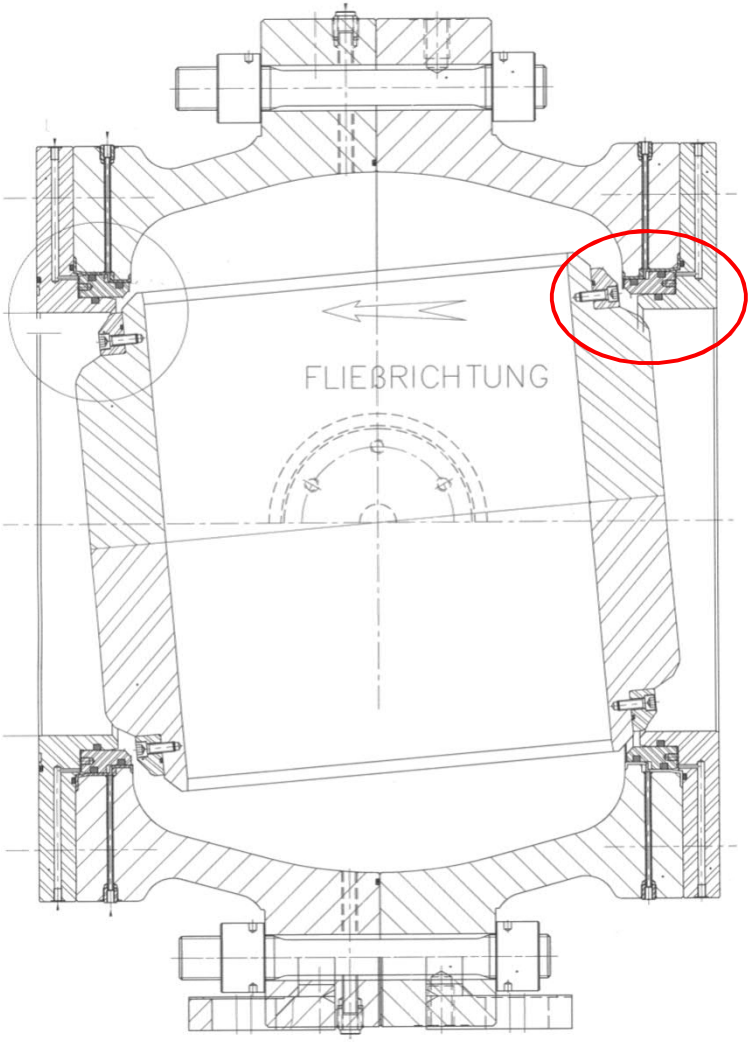
Recommended solution:

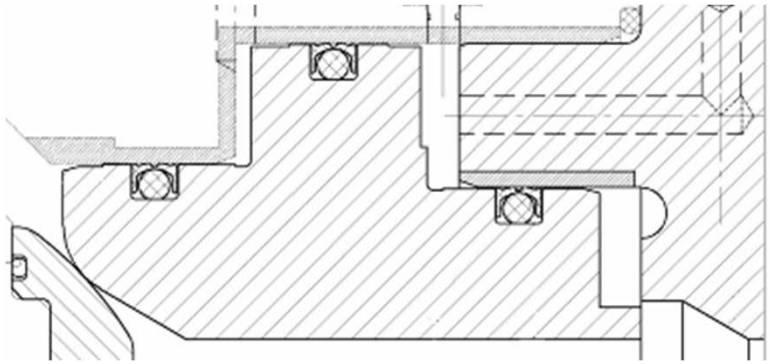


GK35-PH

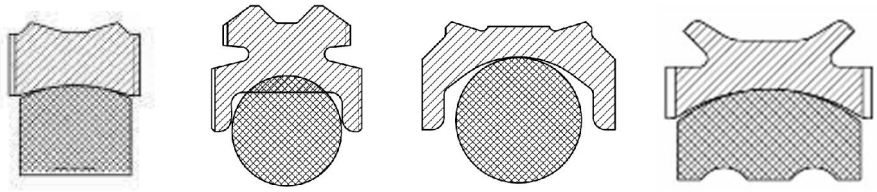
GS35-PH

Spherical valve seals – mobile ring



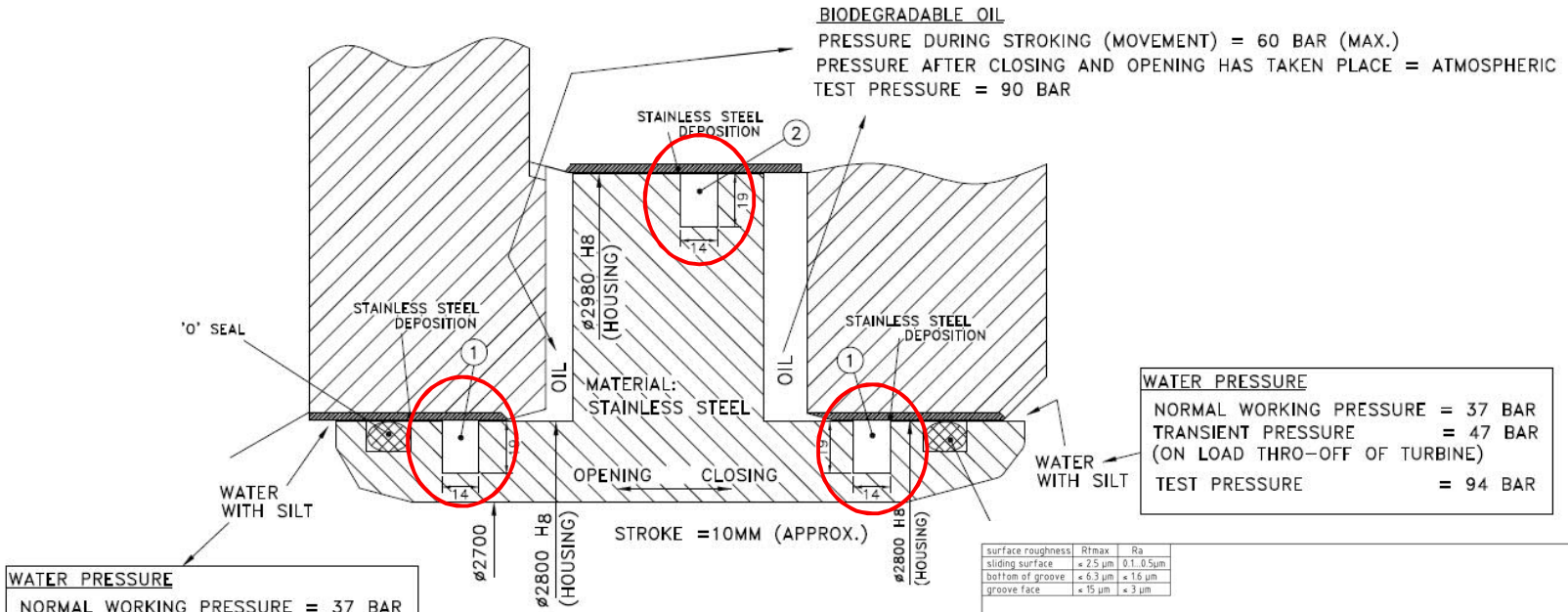


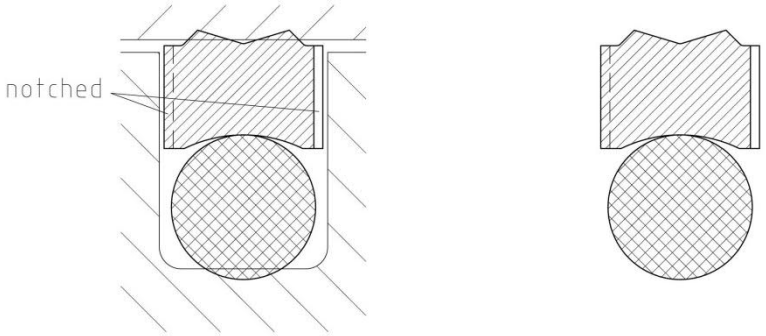
Alternative seal profiles:

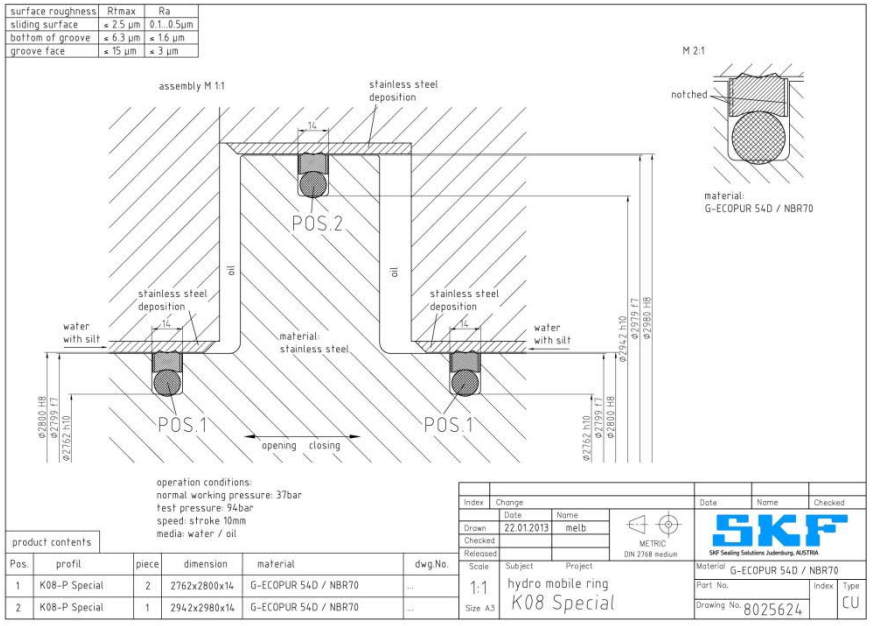


GK08-P profiles and modifications

Spherical valve seals – mobile ring







Spherical valve seals

Projects:

Some examples:

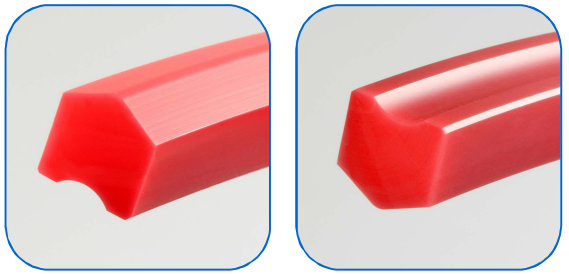
Polska	2545x2585x17.5
China	2200x2220x13.5
Spain	1732.5x1750.4x11.76
Polska	1660x1682x16
France	1469x1485x11.8
Italy	818x830x8.6
India	1775x1797x16
Canada	2180x2200x14.5
India	2409x2437x20
China	3008x3036x22

Spherical valve seals

Standard and customized single and double acting sealing solutions; suitable for large common deformations and misalignments of mobile rings; easy to install.

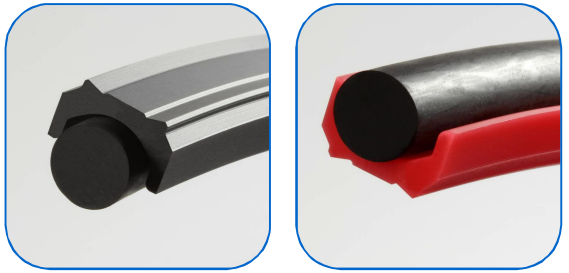
Benefits

- Reliable solutions
- High abrasion resistant materials
- Excellent resistance against sediments
- Long seal service live
- Excellent installation properties
- Special self-lubricated polyurethanes (friction reduction)



Compact seal

Compact seal



O-ring loaded cap seal

5

Butterfly valve seals

Butterfly valve seals

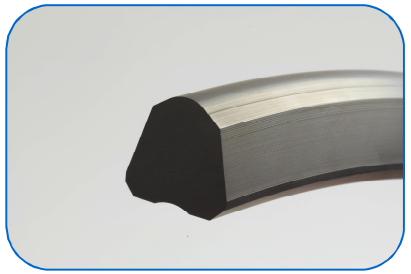
Customized double acting sealing solutions for large diameters with dimensional stability under pressure for many different housing / clamping situations.

Large variety of possible seal designs

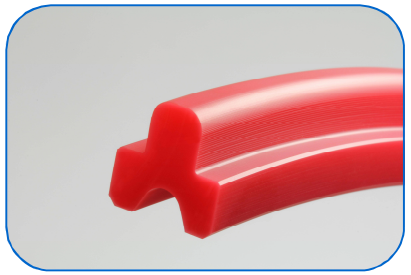
- Large variety of compact seals
- Geometry adjustments to any housing / clamping ring design possible

Flexibility in size and design to cover specific application requirements like

- Extremely large diameter capacity (10 000 mm and more)
- Flexibility to adopt to different housing / clamping ring designs
- High dimensional stability under pressure

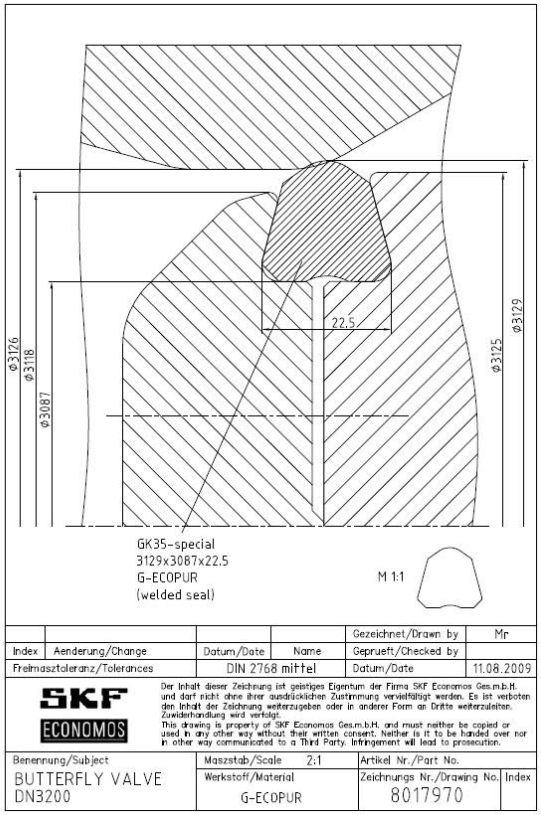


Compact seal



Compact seal

Example: Butterfly valve



				Gezeichnet/Drawn by	Mr
Index	Aenderung/Change	Datum/Date	Name	Geprueft/Checked by	
Freimasztoleranz/Tolerances		DIN 2768 mittel		Datum/Date	11.08.2009

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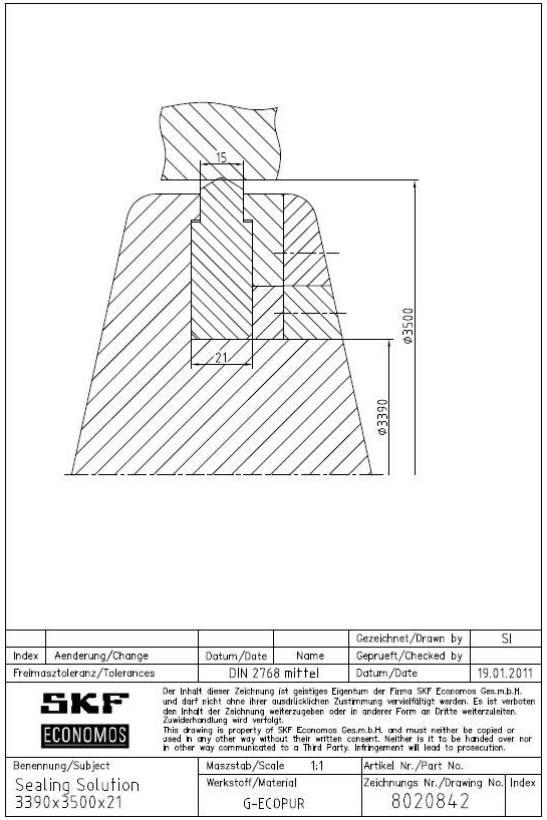
Benennung/Subject	Maszstab/Scale 2:1	Artikel Nr./Part No.	
BUTTERFLY VALVE DN3200	Werkstoff/Material G-ECOPUR	Zeichnungs Nr./Drawing No. 8017970	Index



				Gezeichnet/Drawn by	SI
Index	Aenderung/Change	Datum/Date	Name	Geprueft/Checked by	
Freimasztoleranz/Tolerances		DIN 2768 mittel		Datum/Date	19.01.2011

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Benennung/Subject	Maszstab/Scale 1:1	Artikel Nr./Part No.	
Sealing Solution 3390x3500x21	Werkstoff/Material G-ECOPUR	Zeichnungs Nr./Drawing No. 8020842	Index

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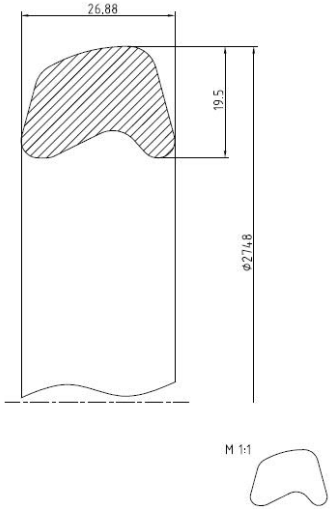


Index	Change		Date	Name	Checked
			Date	Name	
Drawn	06.09.2012	melb			
Checked					
Released					

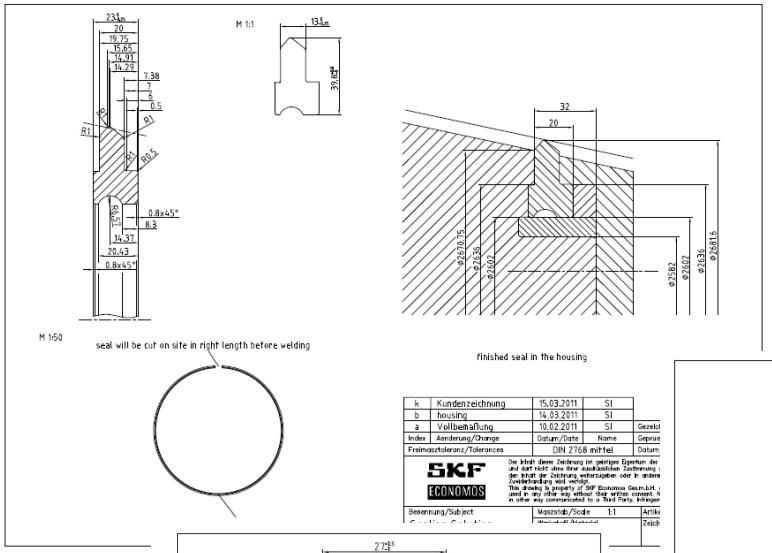
METRIC
DIN 2768 medium

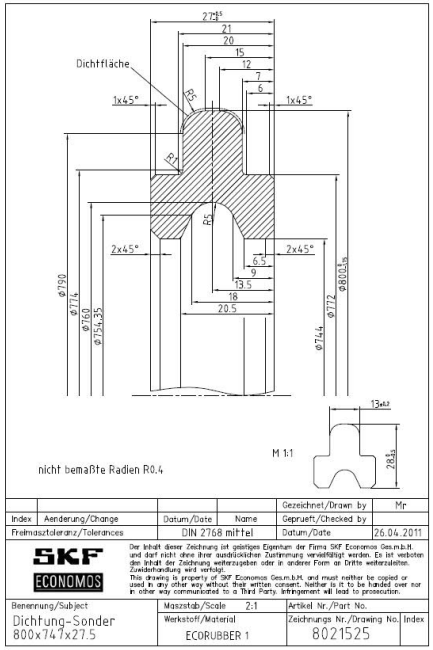
SKF
SKF Sealing Solutions Judenburg, AUSTRIA

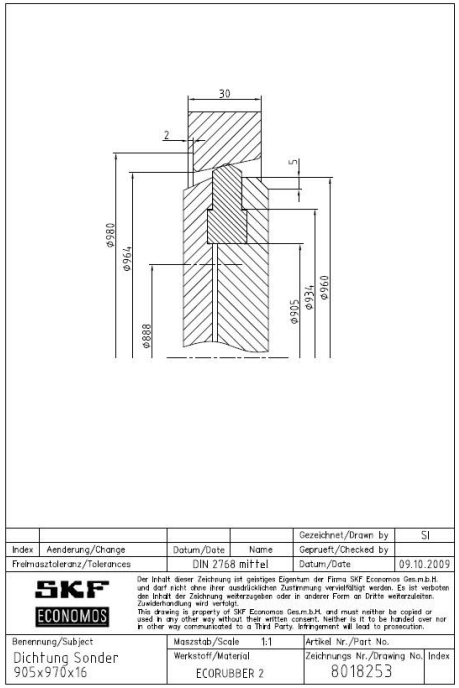
Scale	Subject	Project	Material		
2:1	2748x2709x26.88		Part No.	Index	Type
Size A4	Special Seal		Drawing No. 8024838		CU

SKF®

Example: Butterfly valve







Projects:

Some examples:

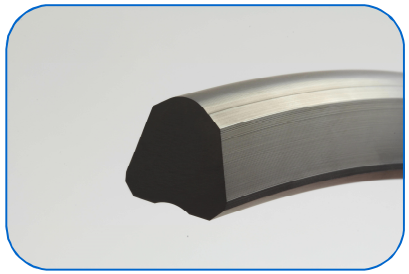
Canada	3087x3129x22.5
Spain	3390x3500x20
China	2602x2681x23
Italy	747x800x27
Austria	905x970x16
Sweden	1488x1693x46
Spain	1590x1700x21
Italy	1510x1610x37.5
Sweden	1841x2018.6x38

Butterfly valve seals

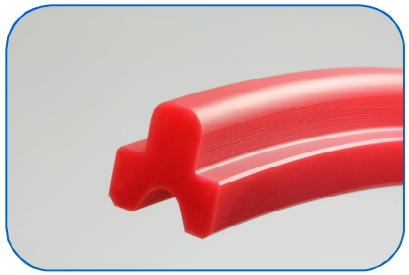
Customized double acting sealing solutions for large diameters with dimensional stability under pressure for many different housing / clamping situations.

Benefits

- Reliable solutions
- Stable fit, no twisting or spiralizing
- Superior resistance against wear and flow erosion
- Excellent resistance against sediments
- Long seal service live
- Mounting endless of on-site joining
- On-site welding and installation service



Compact seal

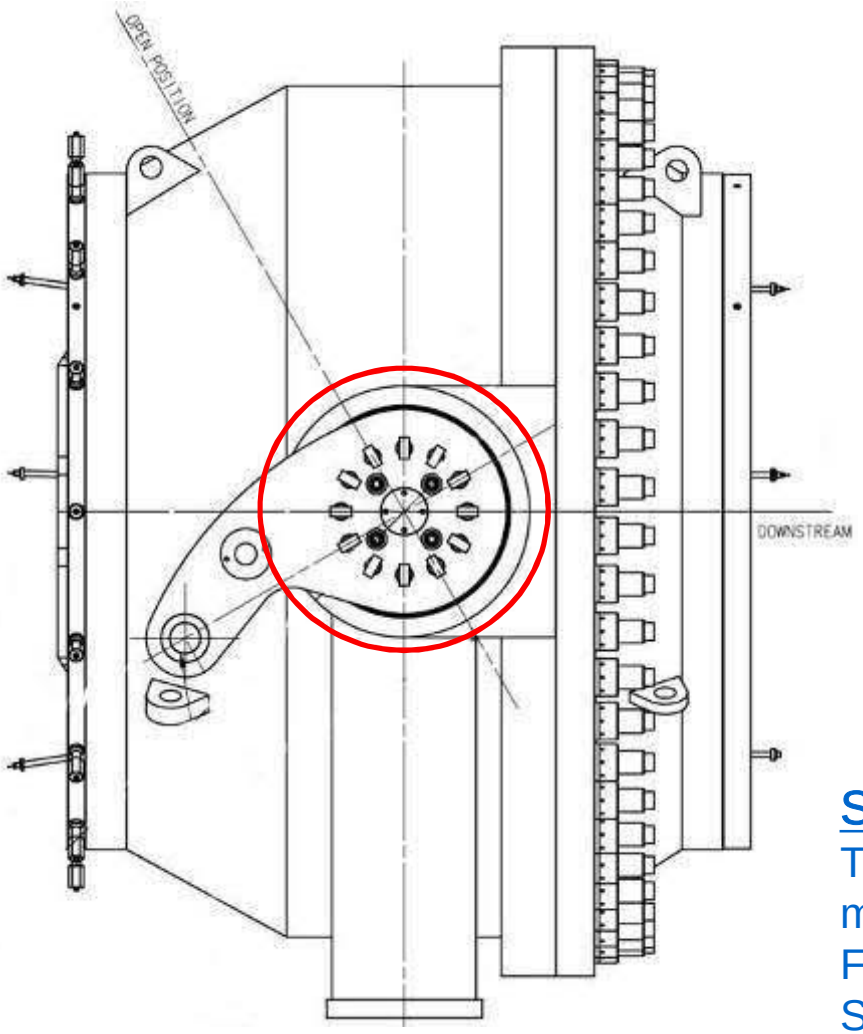


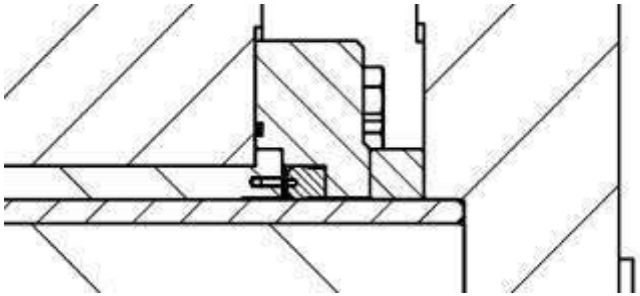
Compact seal

6

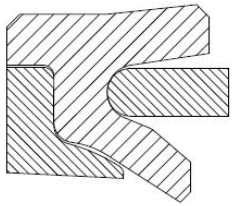
Trunnion seals

Spherical valve seals - trunnion

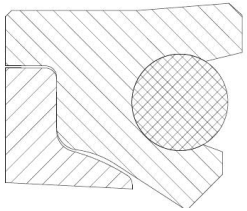


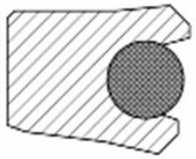


Recommended trunnion seals:



S02- special



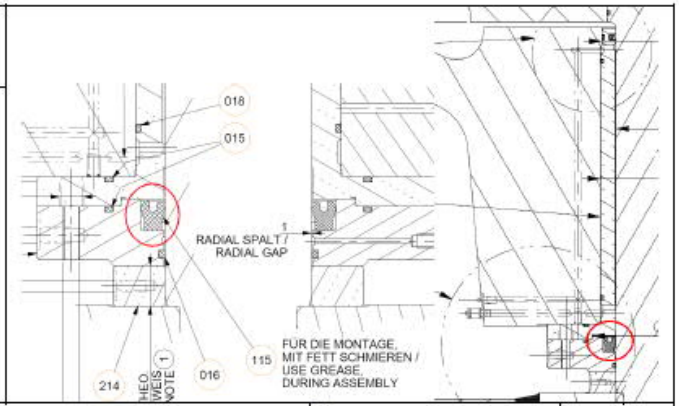


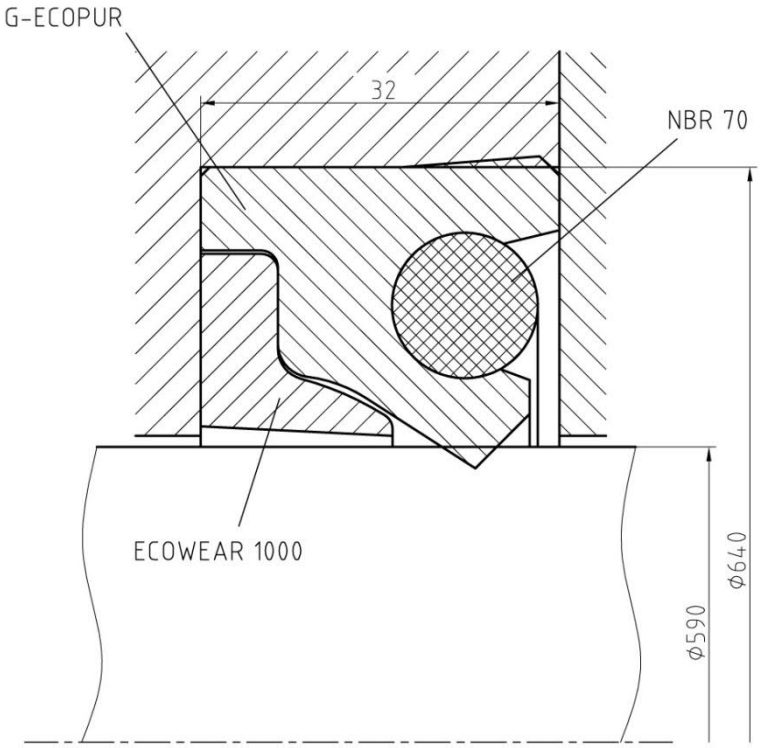
GS03-special

Solution / Advantages:

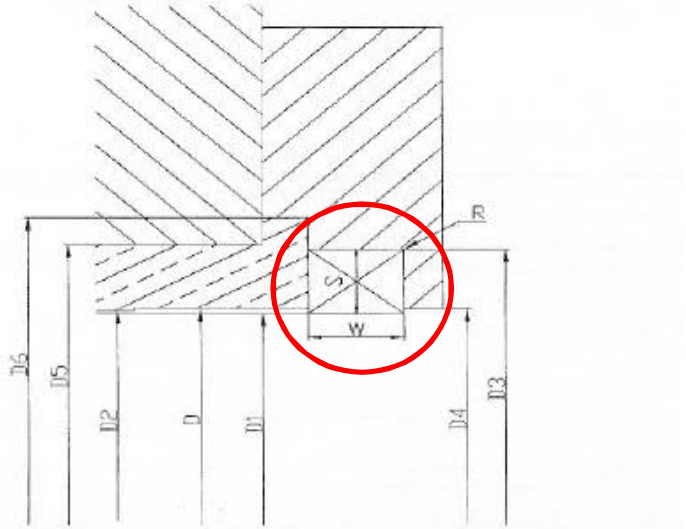
Tailor-made profiles specially designed for rotating movement
Friction and extrusion optimized
Stable fit on OD (no twisting)

Example: Spherical valve seals - trunnion

Description	Outside trunnion seal			
Mounting	Rod			
Sliding surface	Martensitic stainless steel – X20Cr13		Φ 590 d8 -0.26/-0.37	Ra : 0.8
Housing	Carbon steel – S355J2+N		Φ 640 H8 +0.125/0	Ra : 0.8
	Groove	Width (housing support): 32 -0.05/-0.3		Ra : 0.8
		Total free space (longitudinal) : 32 +0.25/0		
		With radius (bottom) : 1 / chamfer (top) : 2x30°		
		Outside diameter : Φ 592 +0.1/-0.1 – pressure side Φ 592 H9 +0.175/0 – back side		
Fluid	Raw dam water as per previous description			
	Maximum pressure : 52.5 bars			
Movement	Translation	Alternative +/- 4 mm	15 times per day	Speed < 0.5 mm/s
	Rotation	Alternative +/- 90°	15 times per day	Speed < 0.15 m/s
	Rest of the time, the movement is reduced to small oscillations around a mean position, with small speed and with or without pressure.			
Strain	Ovalisation of sliding surface (radial displacement) : From -0.23 mm to +0.22 mm			
	Evolution of gap compare to mean values : From 0 to +1 mm			
Requirements	• Excellent tightness level with or without pressure • Operating conditions : o Normal condition : no pressure (bearing in air). o In case of inside trunnion seal failure, fluid : dam water from 0.1 ot 3.5 MPa in dynamic operation / 5.25 MPa in static. o In case of grease injection : "bush" grease at 5 MPa • Small friction factor • Wear resistant, especially to the movement of rotation with pressure • Not sensitive (stable) to the fluid and to "bush" grease.			

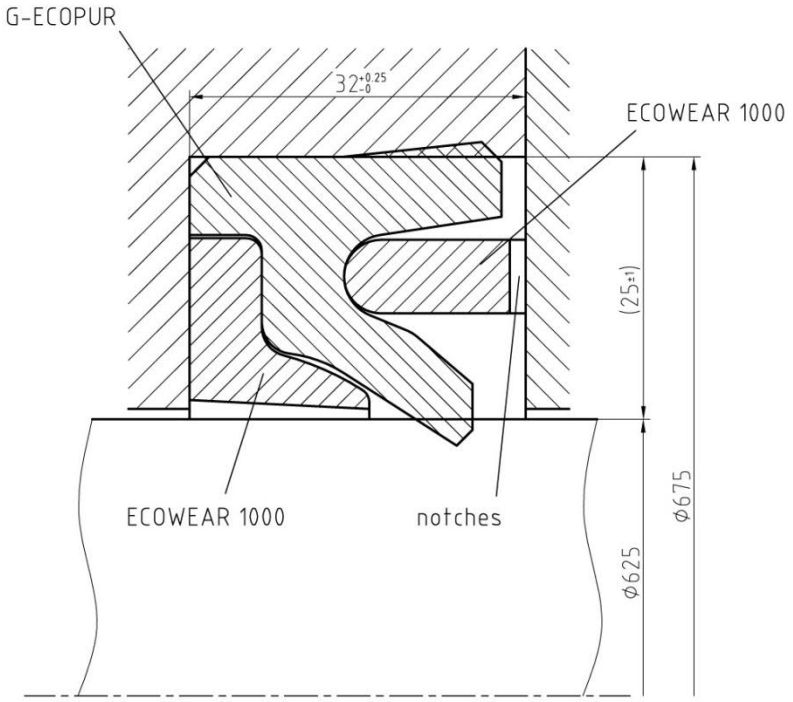


Example: Spherical valve seals - trunnion

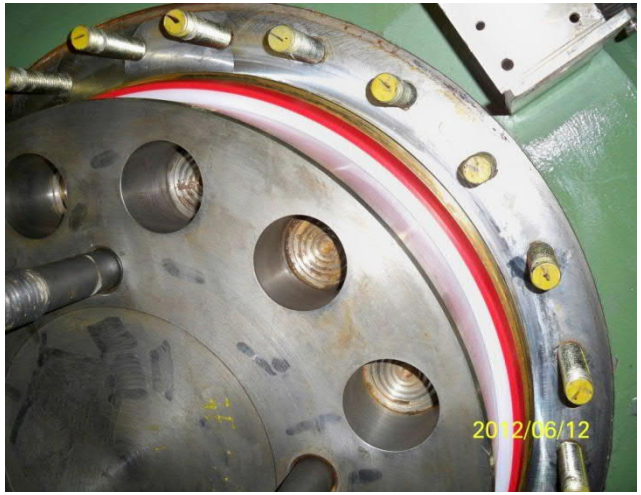


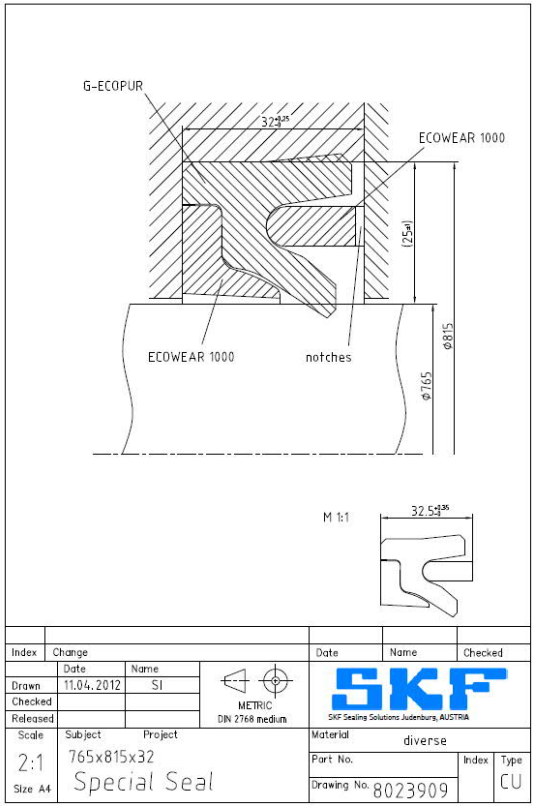
GEOMETRICAL DATA:

Diameters		Tolerances
D1	625 d8	(-0.260/-0.370)
D2	625 H8	(+0.110/0.000)
D	627	(+0.200/+0.000)
D3	675 H8	(+0.125/+0.000)
D4	629	(+0.200/+0.000)
D5	665 H8f8	(+0.125/0.000)/ (-0.080/-0.205)
D6	685 H8f8	(+0.125/0.000)/ (-0.080/-0.205)



Example: Spherical valve seals - trunnion





7

Ring gate seals

Ring gate seals

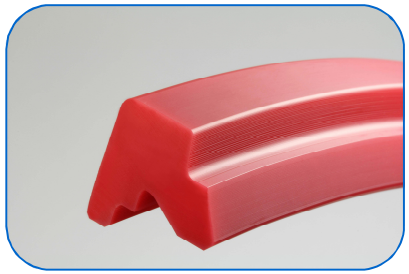
Customized single acting sealing solutions for diameters up to 10 000 mm and above.

Large variety of possible seal designs

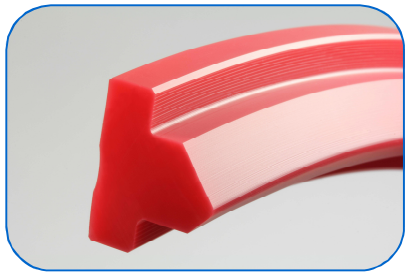
- Flexible upper ring gate seals
- Compact lower ring gate seals

Flexibility in size and design to cover specific application requirements like

- Extremely large diameter capacity (10.000 mm and more)
- Flexibility to adopt to different housing / clamping ring designs
- Flexible upper ring gate design
- Compensation of tolerances and misalignments

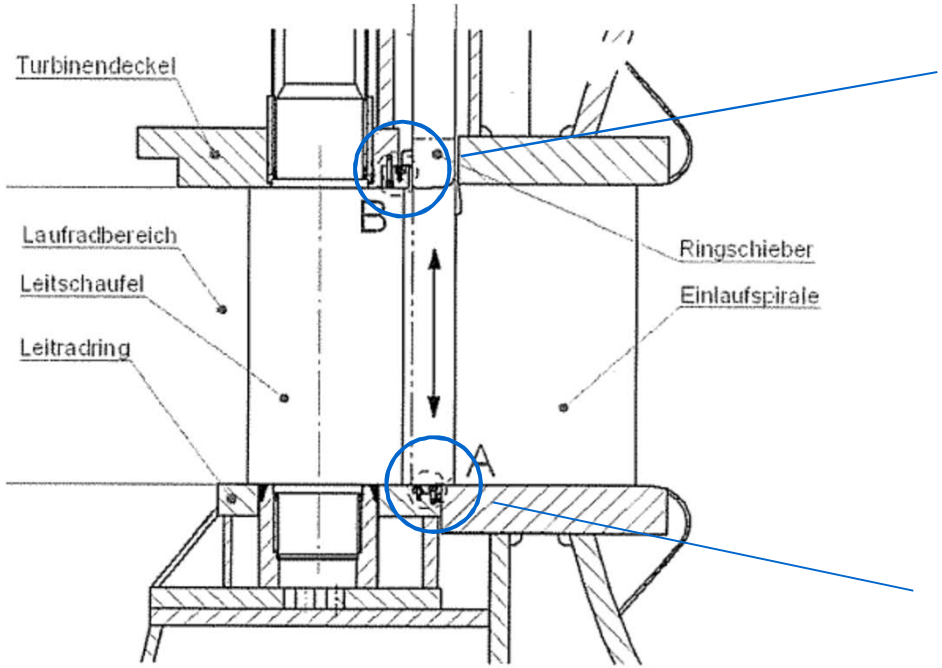


Upper ring gate seal

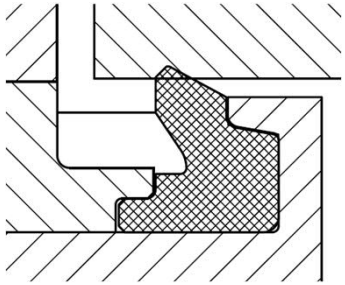


Lower ring gate seal

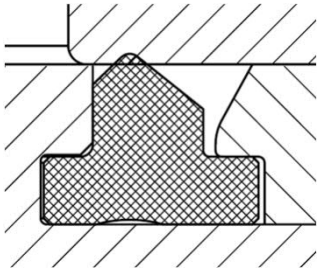
ring gate seals



upper ring gate seal

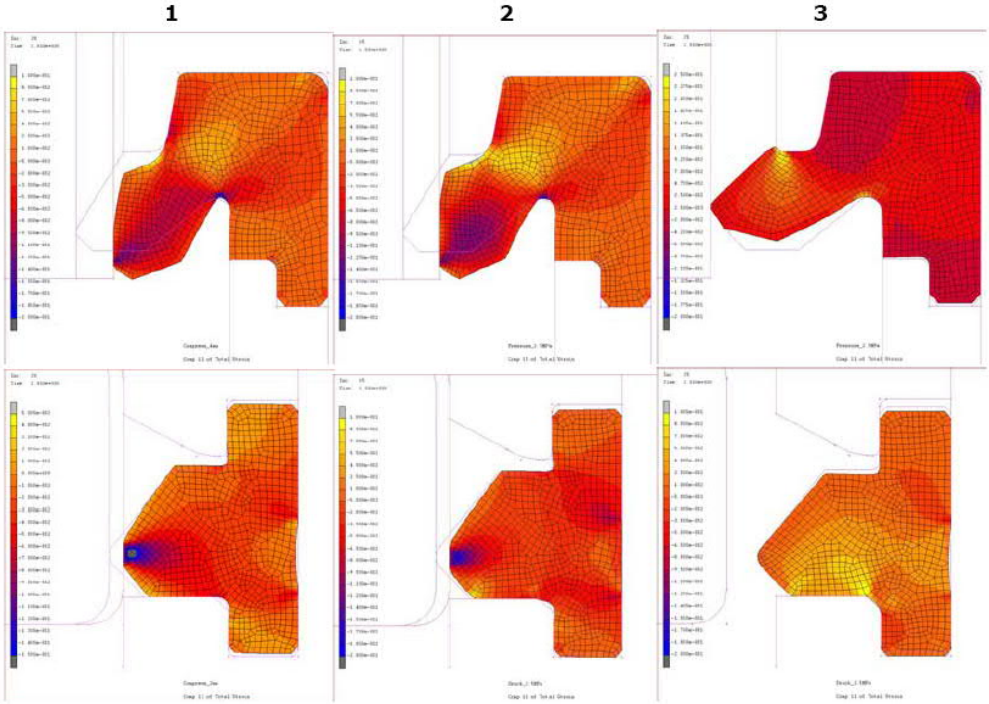


lower ring gate seal



Ring gate seals

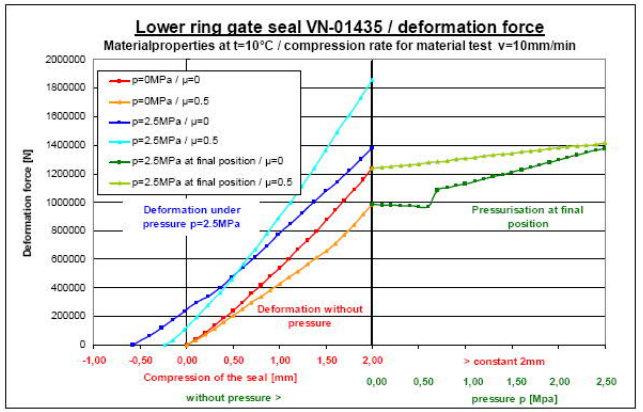
Upper ring gate seal

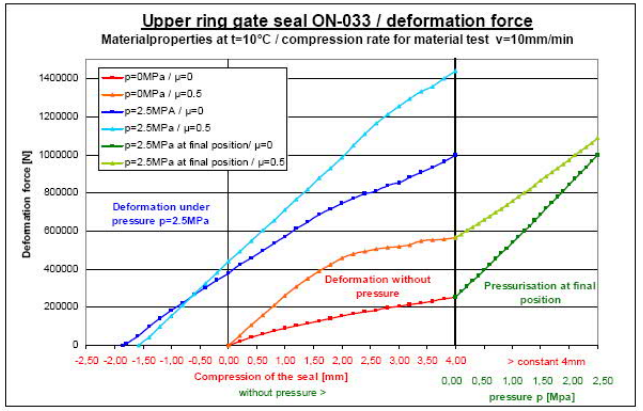


1 .....Deformation of the seal when the ring gate is closed, pressure p= 0 MPa
Temperature=22,5°C / µ=0,5

2 .....Deformation of the seal when the ring gate is closed, pressure p=2,5 MPa
Temperature=22,5°C / µ=0,5

3 .....Deformation of the seal when the ring gate is open, pressure p=2,5 MPa
Temperature=22,5°C / µ=0


Lower ring gate seal VN-01435 / deformation force
Materialproperties at t=10°C / compression rate for material test v=10mm/min
Deformation force [N]
p=0MPa / µ=0
p=0MPa / µ=0.5
p=2.5MPa / µ=0
p=2.5MPa / µ=0.5
p=2.5MPa at final position / µ=0
p=2.5MPa at final position / µ=0.5
Deformation under pressure p=2.5MPa
Pressurisation at final position
Deformation without pressure
> constant 2mm
Compression of the seal [mm]
without pressure >
pressure p [Mpa]


Upper ring gate seal ON-033 / deformation force
Materialproperties at t=10°C / compression rate for material test v=10mm/min
Deformation force [N]
p=0MPa / µ=0
p=0MPa / µ=0.5
p=2.5MPA / µ=0
p=2.5MPa / µ=0.5
p=2.5MPa at final position/ µ=0
p=2.5MPa at final position / µ=0.5
Deformation under pressure p=2.5MPa
Deformation without pressure
Pressurisation at final position
> constant 4mm
Compression of the seal [mm]
without pressure >
pressure p [Mpa]

Lower ring gate seal

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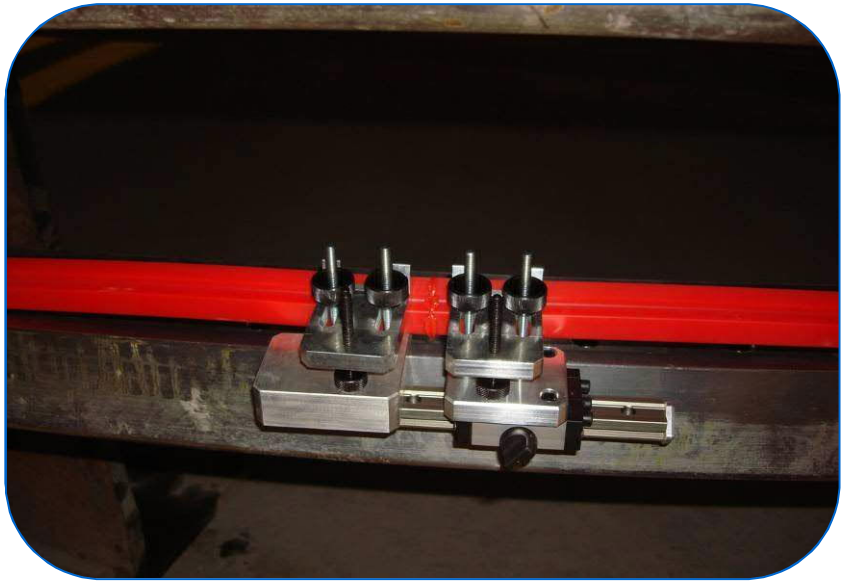
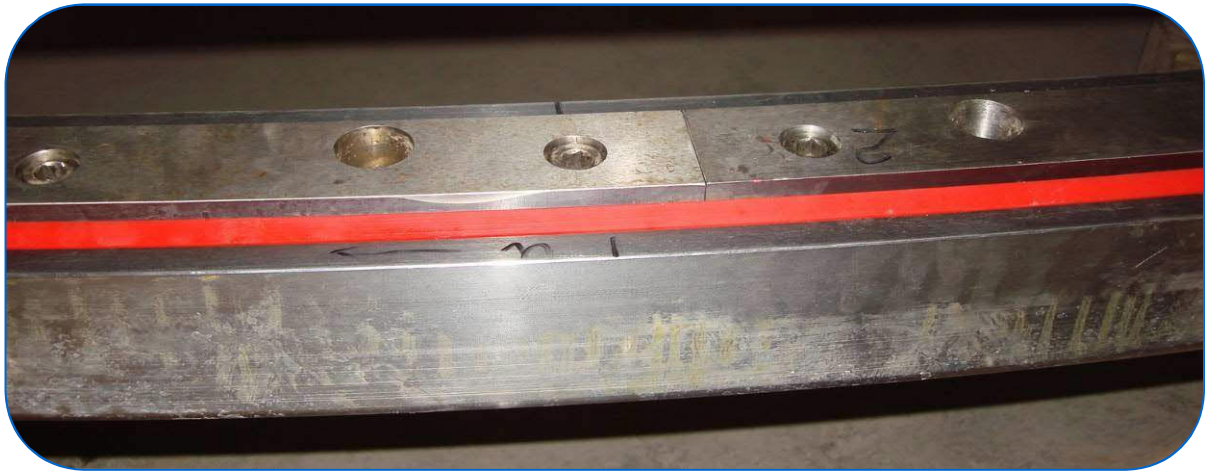
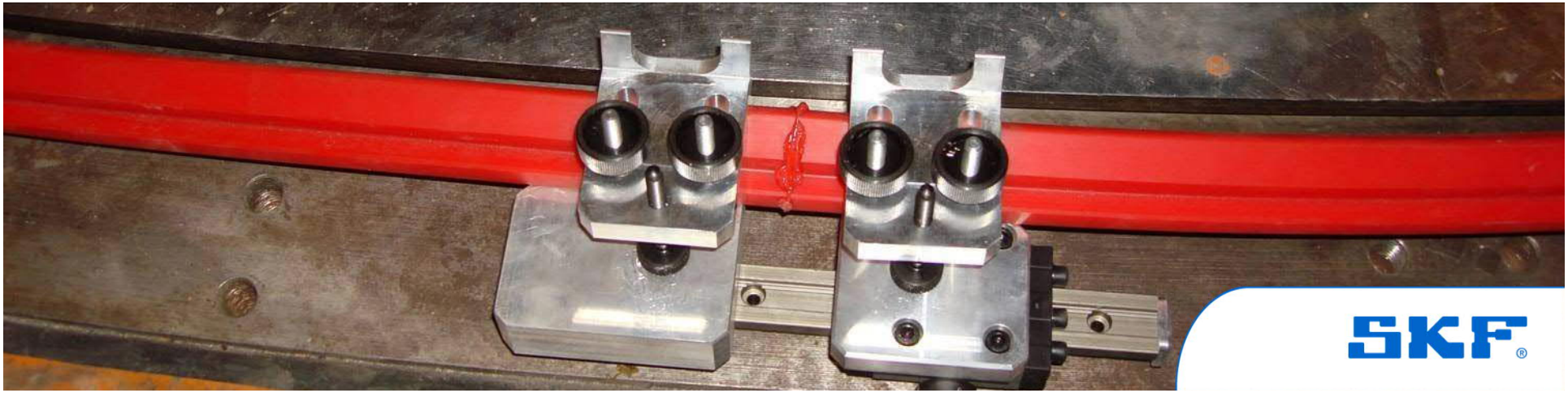
XiaoWan – project

XiaoWan – project





XiaoWan – project

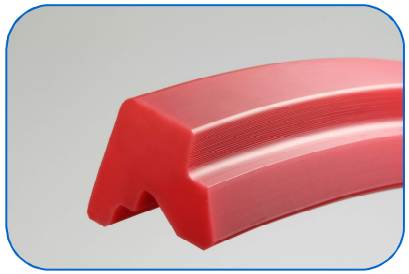


Ring gate seals

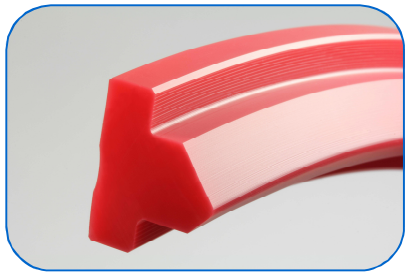
Customized single acting sealing solutions for diameters up to 10 000 mm and above.

Benefits

- Frequently applied and reliable solutions
- Superior resistance against wear and flow erosion
- Excellent resistance against sediments
- Long seal service live
- Mounting endless of on-site joining
- On-site welding and installation service



Upper ring gate seal

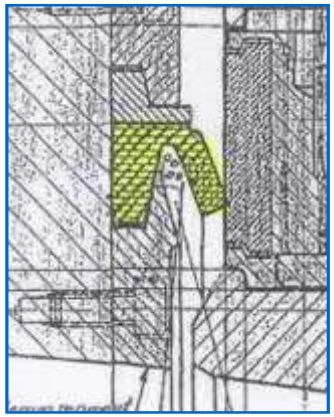


Lower ring gate seal

8

Others / Special applications

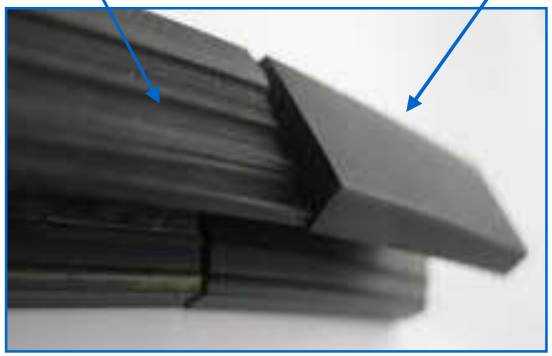
Example “outer collar seal”

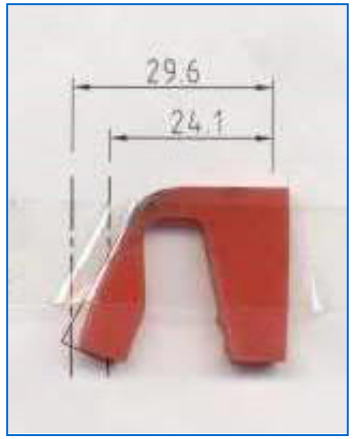


Materials – comparison

Wear after 3 month

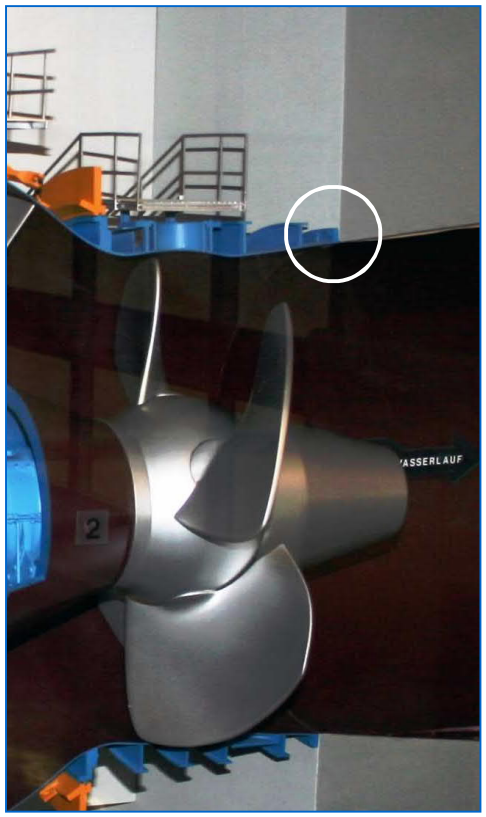
Original new seal





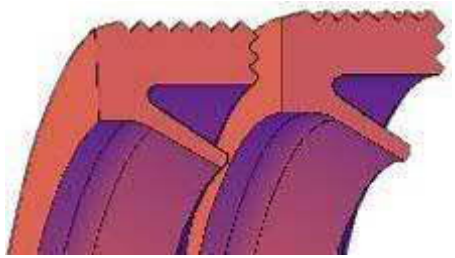
Flange seals

Flanges of pipes / valves or between pipes and concrete walls



Solution

Tailor-made profile with radial and axial static sealing edges and flexible inner lip shape to compensate corroded housing and misalignment

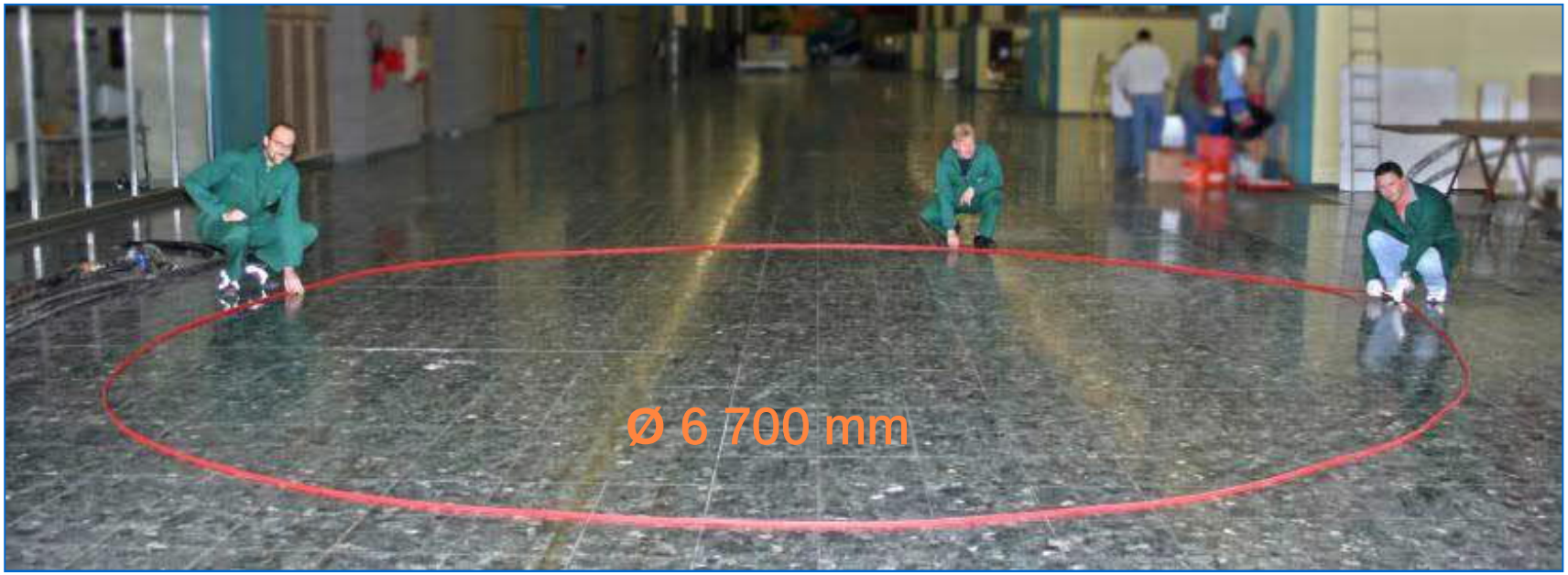


Advantages

Split on-site joining solution achieving performance and integrity of endless seal

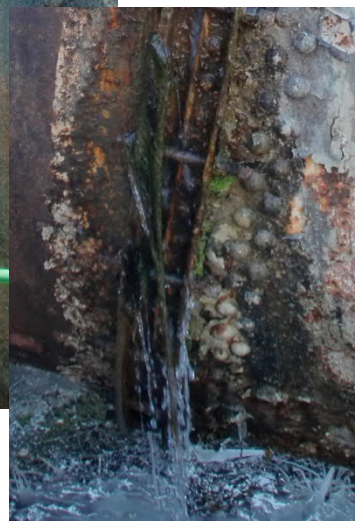
Reduced downtime and installation costs

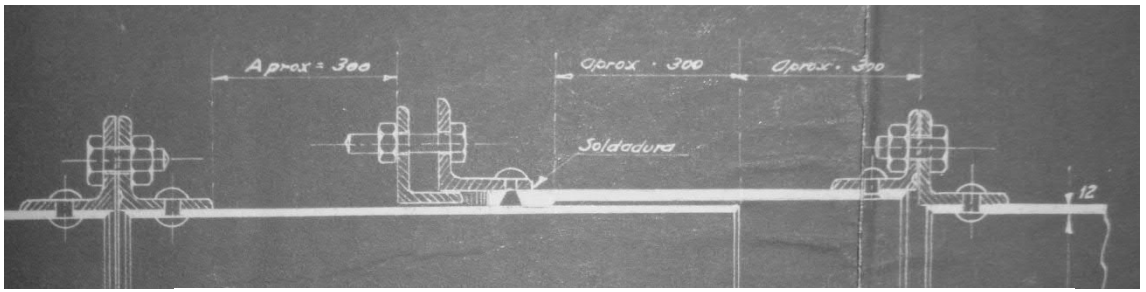
Flange seals

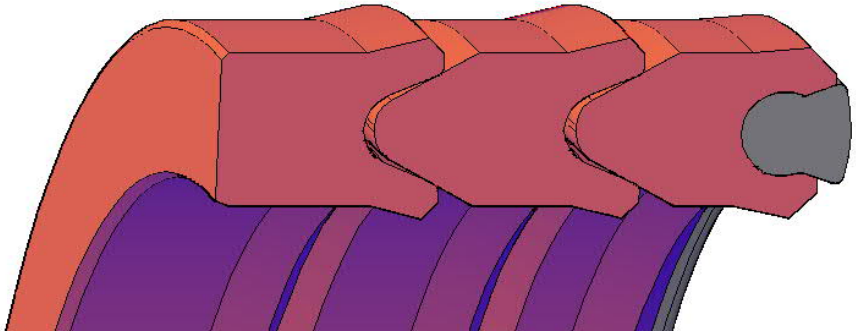


Expansion / dismantling joints

Sealing solution for joints of penstocks





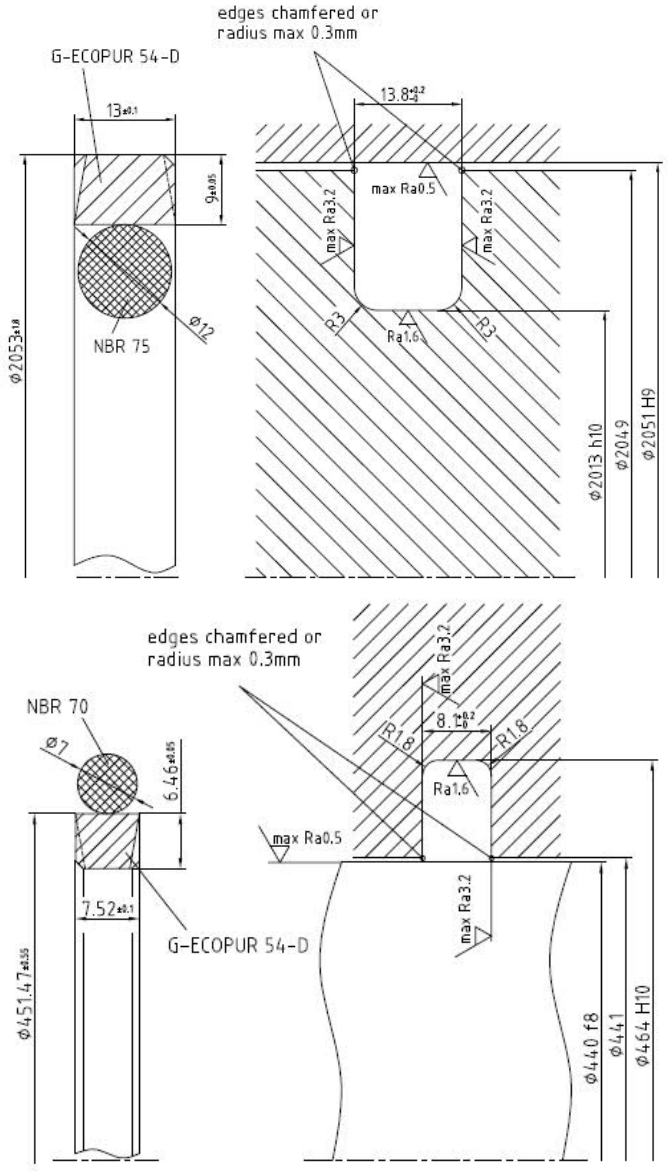


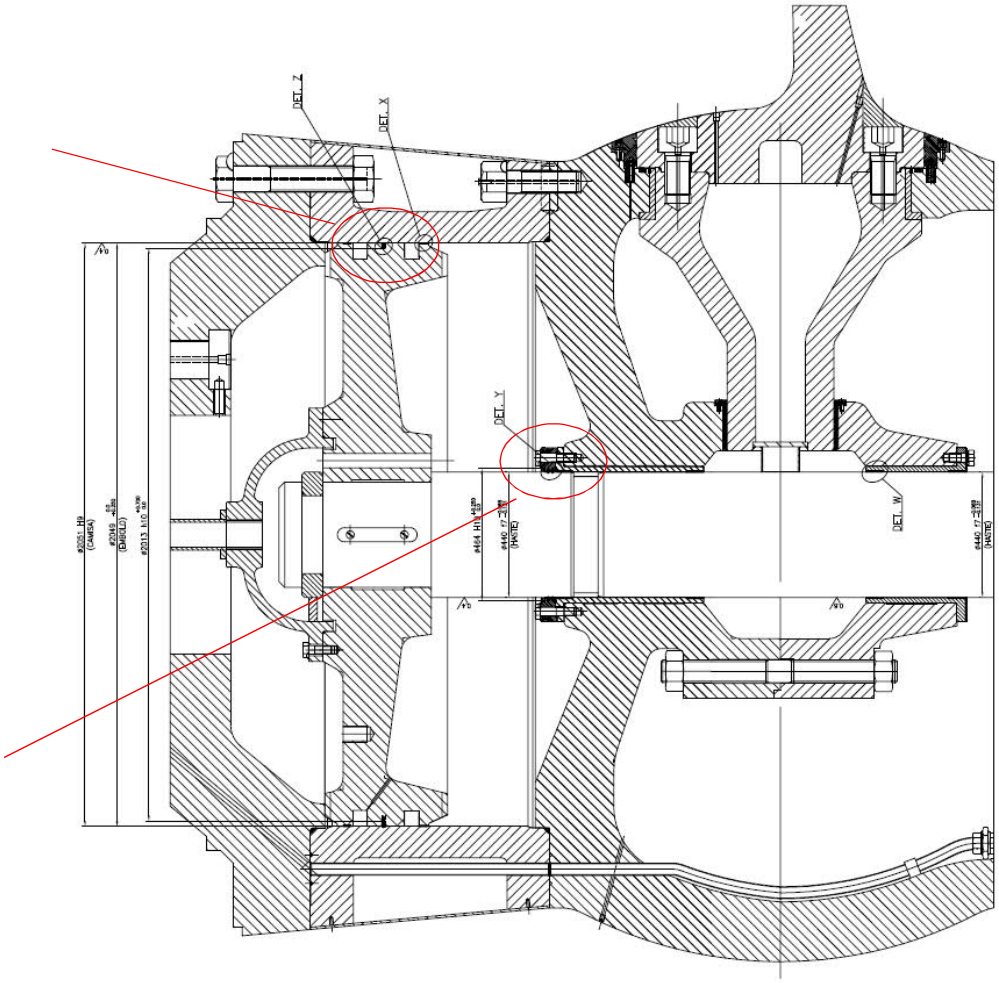
Solution / Advantages:

Tailor-made profiles with multiple sealing edges activated by special wedge action due to axial compression

Easy adjustable set height

Kaplan- Servo motor

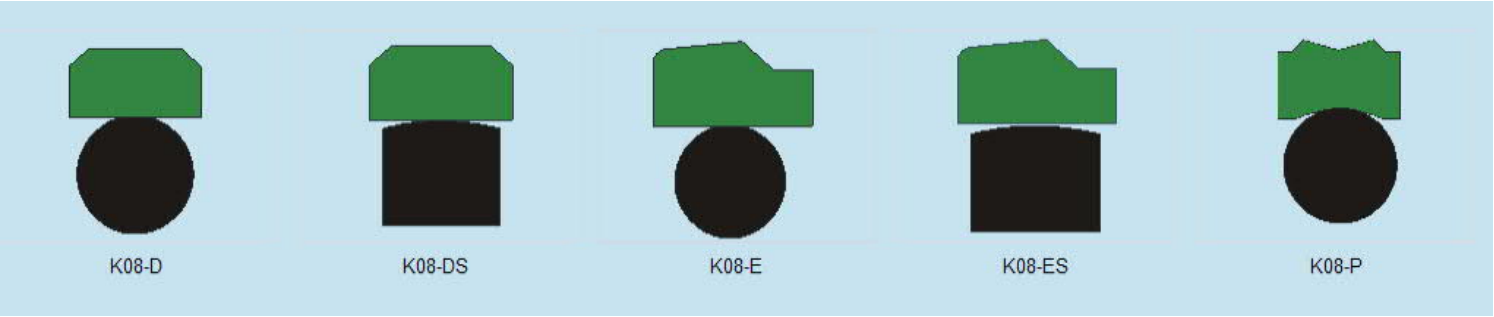




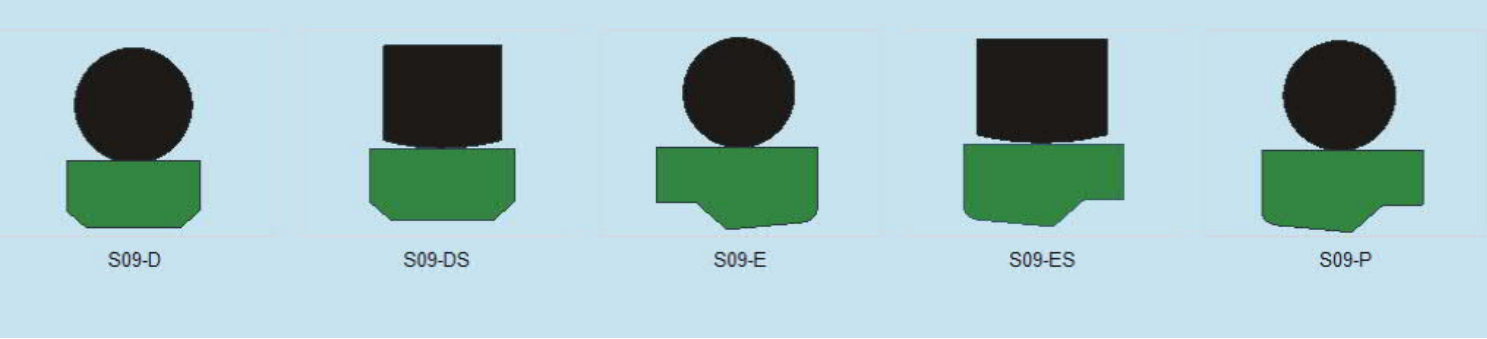
X-SLIDE / F-SLIDE SEALS

X - Slide / F - Slide profiles:

piston seals

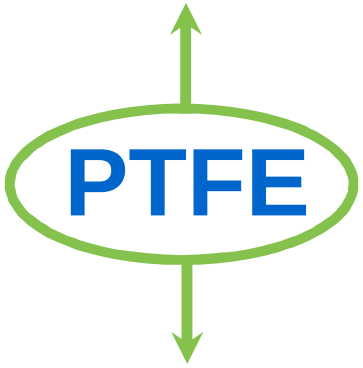


rod seals



X-SLIDE / F-SLIDE SEALS

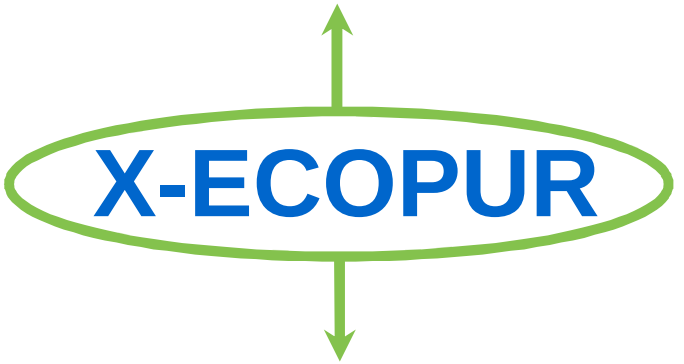
F–Slide seals



good chemical resistance
good thermal resistance

poor sealing effect
hard to install

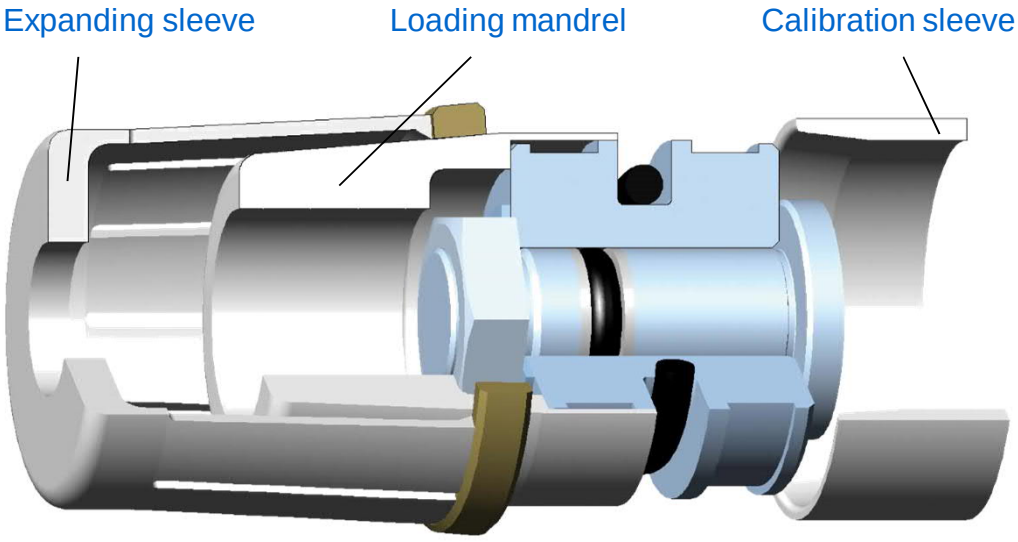
X–Slide seals



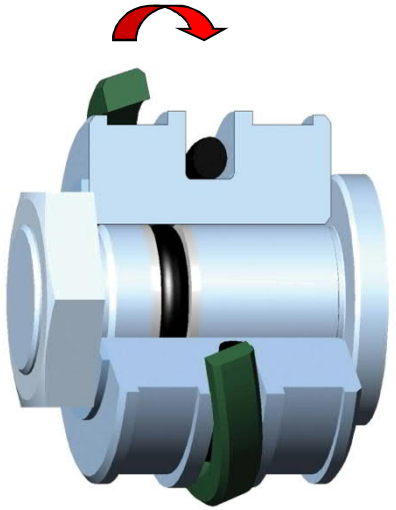
excellent sealing effect
good extrusion resistance
good wear characteristics
easy to install

chem. and therm. resistance
not as good as PTFE

PTFE	TEST PARAMETERS	X-ECOPUR®
+	• Installation properties	+++++
+++++	• Friction / Stick-slip effect	++++
++	• Leakage behaviour	+++++
+++	• Wear characteristics	+++++
+++	• Pressure resistance	+++++

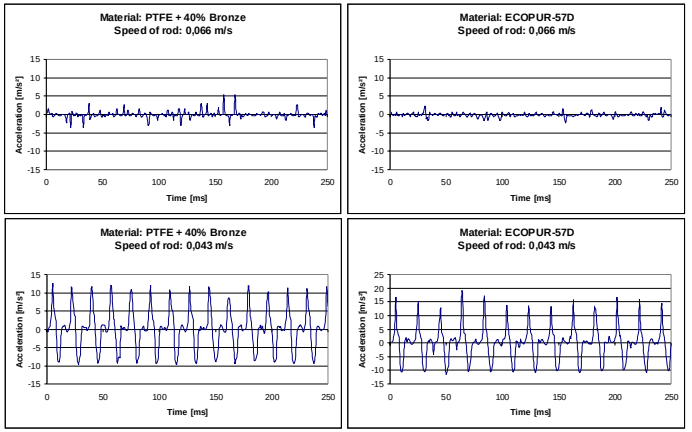


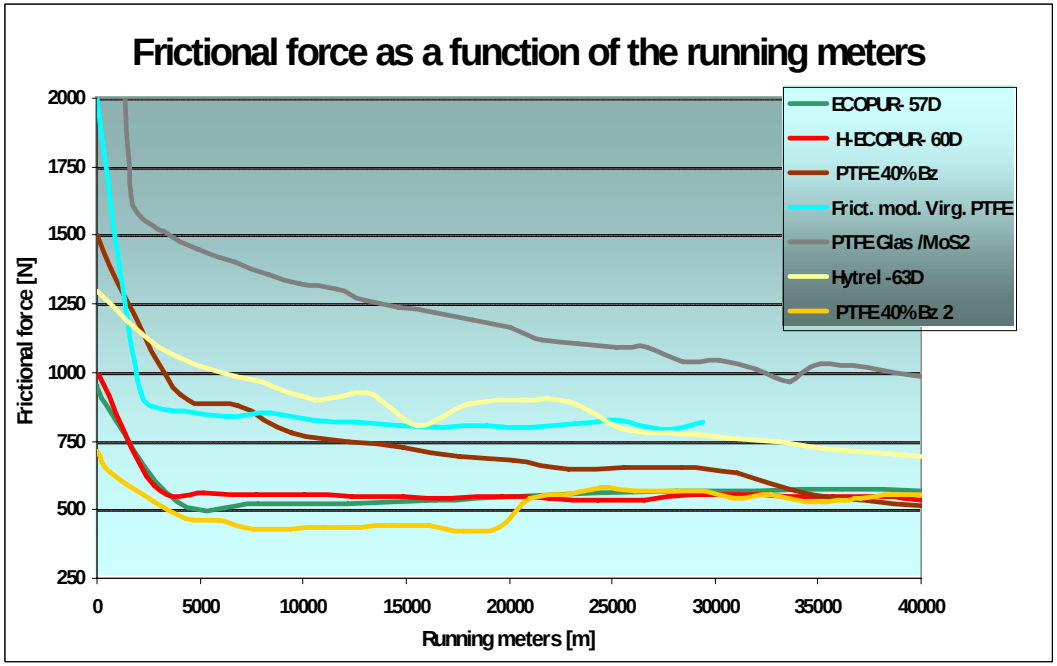
Installation procedure of standard PTFE seals



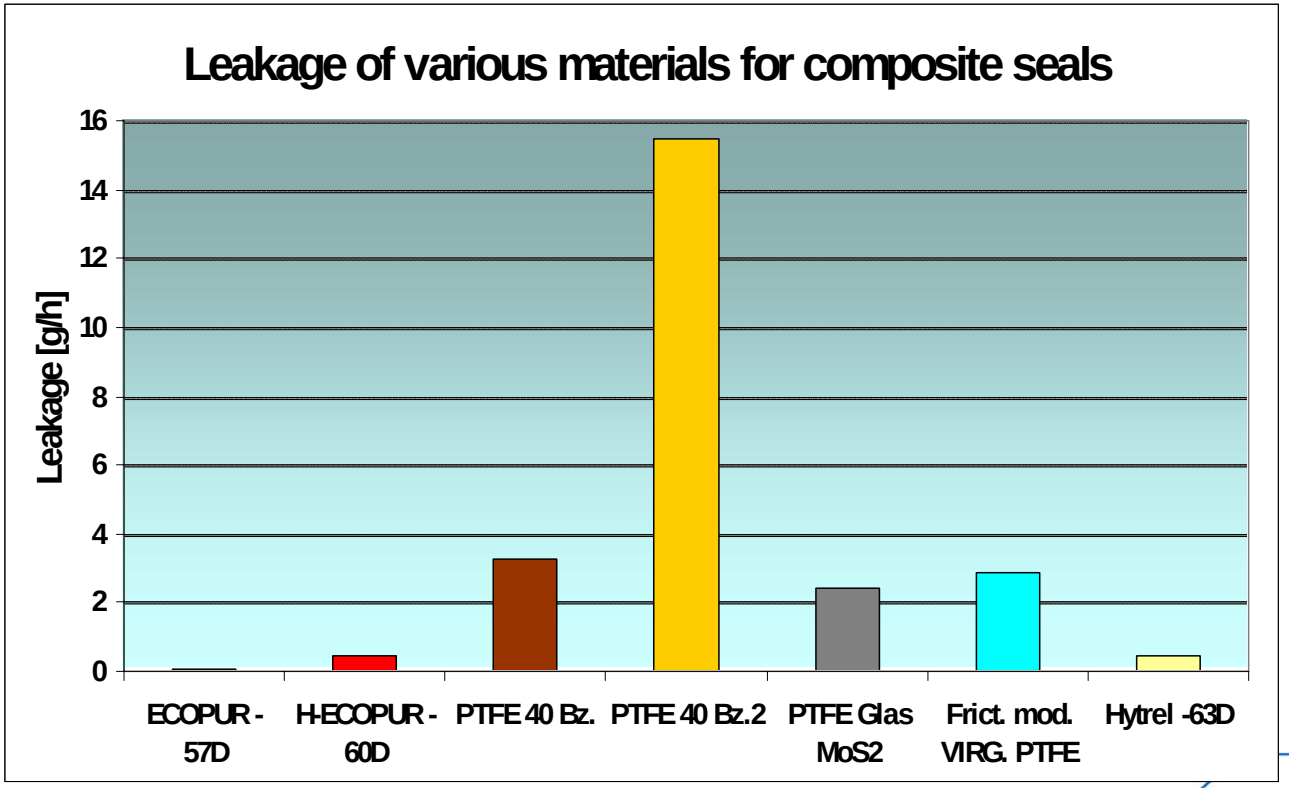
Installation procedure of X-SLIDE® seals

PTFE	TEST PARAMETERS	X-ECOPUR®
+	• Installation properties	+++++
+++++	• Friction / Stick-slip effect	++++
++	• Leakage behaviour	+++++
+++	• Wear characteristics	+++++
+++	• Pressure resistance	+++++



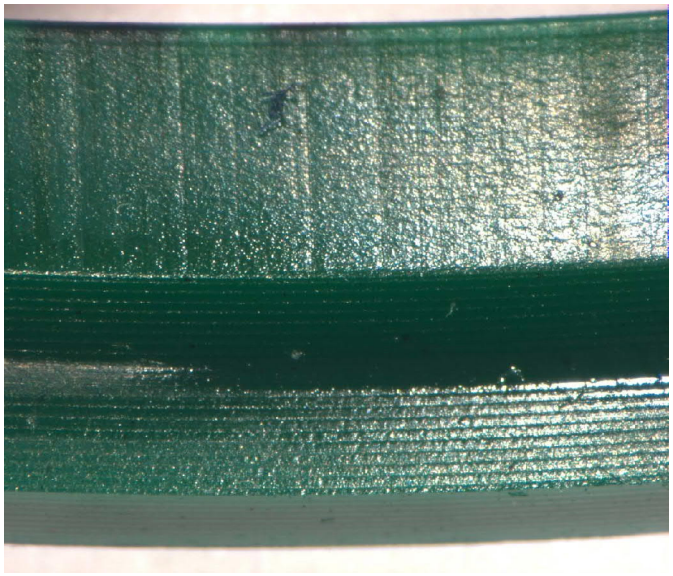


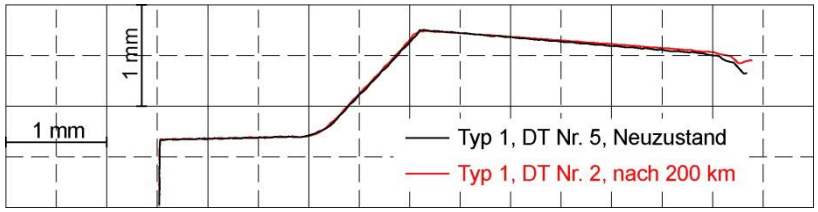
PTFE	TEST PARAMETERS	X-ECOPUR®
+	• Installation properties	+++++
+++++	• Friction / Stick-slip effect	++++
++	• Leakage behaviour	+++++
+++	• Wear characteristics	+++++
+++	• Pressure resistance	+++++



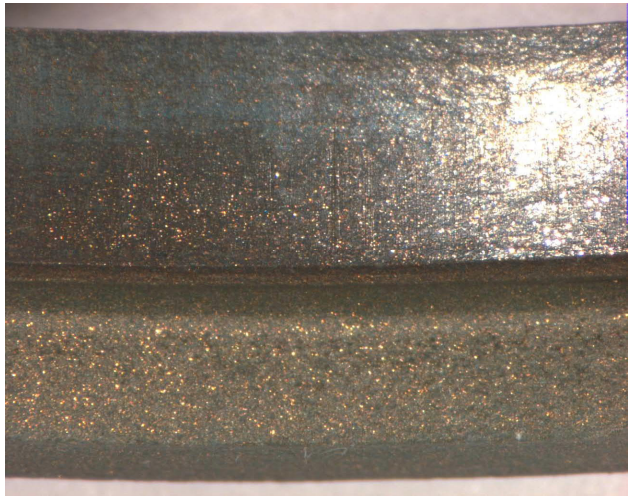
PTFE	TEST PARAMETERS	X-ECOPUR®
+	• Installation properties	+++++
+++++	• Friction / Stick-slip effect	++++
++	• Leakage behaviour	+++++
+++	• Wear characteristics	+++++
+++	• Pressure resistance	+++++

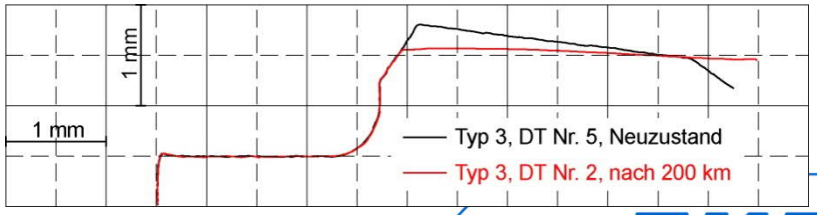
X-ECOPUR





PTFE Bronze





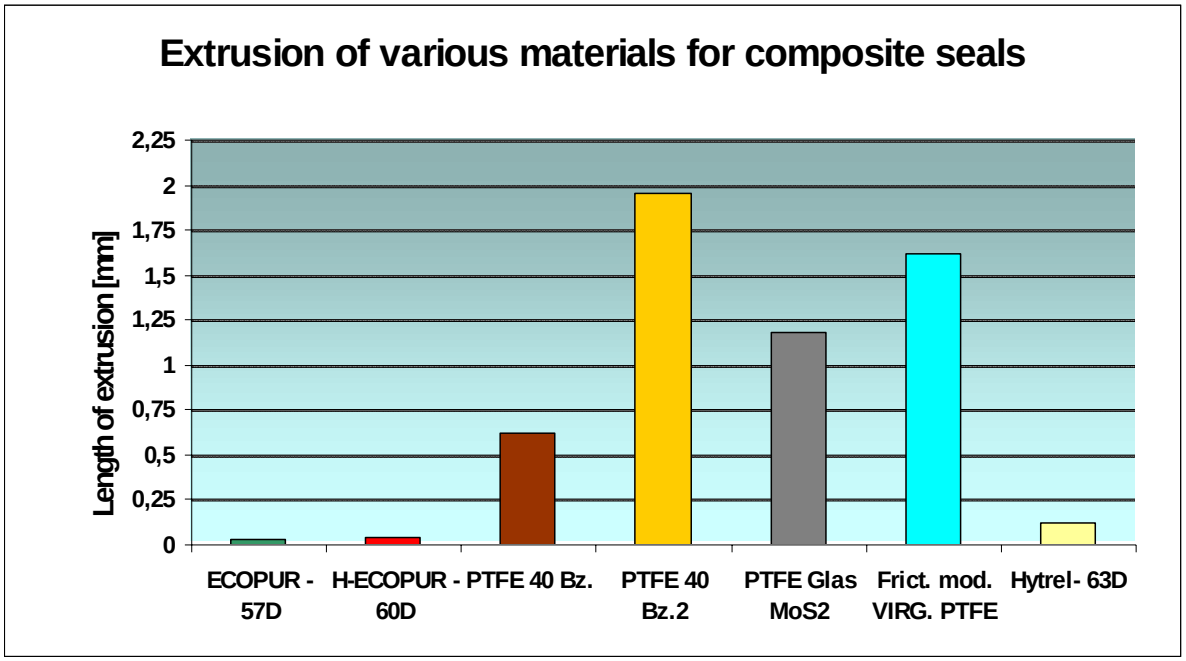
PTFE	TEST PARAMETERS	X-ECOPUR®
+	• Installation properties	+++++
+++++	• Friction / Stick-slip effect	++++
++	• Leakage behaviour	+++++
+++	• Wear characteristics	+++++
+++	• Pressure resistance	+++++

PTFE Bronze
poor quality

PTFE Bronze
medium quality

PTFE Bronze
good quality

ECOPUR - 57D
natural colored



SKF